FINAL
TNRCC PSTD LPST *SITE CLOSURE REQUEST FORM*

FORMER BUILDING 2093 GAS STATION,
KELLY AFB, TEXAS

AETC Contract No. F41689-96-D-0710
Order No. 5015

Prepared for

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
TECHNOLOGY TRANSFER DIVISION
BROOKS AIR FORCE BASE, TEXAS

and

SA-ALC/EMRO
KELLY AIR FORCE BASE, TEXAS

July 1998

Prepared by

PARSONS ENGINEERING SCIENCE, INC.
1700 Broadway, Suite 900
Denver, Colorado 80209

Walton, Norman

From: Hansen, Jerry E, Mr, HQAFCEE [Jerry.Hansen@HQAFCEE.brooks.af.mil]
Sent: Tuesday, August 08, 2000 10:16 AM
To: 'nwalton@dtic.mil'
Subject: Distribution statement for AFCEE/ERT reports

Norman, This is a followup to our phone call. The eight boxes of reports you received from us are all for unlimited distribution. If you have any questions, you can contact me at DSN 240-4353.

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TEXAS NATURAL RESOURCE CONSERVATION COMMISSION
PETROLEUM STORAGE TANK DIVISION

LPST SITE CLOSURE REQUEST FORM

This form is to be used to request closure for Leaking Petroleum Storage Tank (LPST) cases. The soil and groundwater cleanup goals must be met prior to submitting this form. These cleanup goals should be derived from either:

- the TWC *Guidance Manual for LPST Cleanups in Texas*, January 1990 **so long as these goals were achieved prior to November 8, 1995**, or
- the TNRCC *Risk-Based Corrective Action for Leaking Storage Tank Sites* document, January 1994 (RG-36).

Submission of this Site Closure Request constitutes certification by the Responsible Party, Corrective Action Specialist (CAS), and Corrective Action Project Manager (CAPM) that all necessary corrective actions have been completed and final closure of the subject site is appropriate at this time. By signing this Site Closure Request, the Responsible Party, CAS, and CAPM acknowledges that no further corrective actions, with the exception of activities subsequently approved by the TNRCC, will be eligible for reimbursement after the RP's signature date. Although costs for activities such as groundwater monitoring or remediation system operation and maintenance may have been approved for an annual period, these activities should cease upon submission of the Site Closure Request as these activities will not be considered eligible for reimbursement beyond the date of the Site Closure Request. Additionally, any costs relating to site assessment or other corrective action activities will not be eligible for reimbursement if the activities are conducted after the date of the Site Closure Request, unless specifically approved by the TNRCC. If, upon review by the TNRCC, the TNRCC concurs that the site meets the conditions for final closure, the costs for closure activities necessary to restore the site to its original condition will be reviewed and approved as appropriate. If the TNRCC determines that the site does not meet the conditions for final closure, the TNRCC will request a workplan and cost proposal for the next appropriate corrective action activity necessary to proceed towards final closure unless appropriate activities have previously been approved. The only type of proposal that should be attached to the Site Closure Request is for site closure costs. Any proposals attached to the Site Closure Request for activities other than site closure will not be processed and will be withdrawn from consideration.

If any of the following apply, the site is not ready for closure and this form should not be submitted:

- **The appropriate LPST cleanup goals have not been met (a proposal for the next appropriate step should be submitted instead);**
- **Phase-separated hydrocarbons (>0.1 feet) currently exist at the site;**
- **The contaminant plume is increasing in size; or**
- **All wastes and other material generated from the site have not been properly disposed;**

Do not use this form:

- **if the release was not from a regulated underground or aboveground storage tank;**
- **for tank removal-from-service activities not associated with an LPST site (use the *Release Determination Report Form* (TNRCC-0621) or other appropriate format);**
- **for situations where the second set of confirmation samples collected during tank removal-from-service activities confirms suitability for closure (use the *Release Determination Report Form* (TNRCC-0621) or other appropriate format); or**
- **for shutdown of remediation systems or for plugging of monitor wells when site closure is not yet appropriate.**

If asked to initiate additional activities, submit a workplan and preapproval request for those activities on sites eligible for reimbursement. Please review the document entitled *Preapproval for Corrective Action Activities* (RG-111) for procedures on preapproval requests and the other PST guidance pamphlets and rules for additional information on LPST sites.

Complete all blanks and check "yes" or "no" for all inquiries. **IF A COMPLETED *ASSESSMENT REPORT FORM* (TNRCC-0562) WAS PREVIOUSLY SUBMITTED, YOU DO NOT NEED TO ANSWER THE QUESTIONS WITHIN THE DARK OUTLINED AREAS UNLESS THE INFORMATION HAS CHANGED.** If the question is not applicable to this site, indicate with N/A. If the answer to the question is unknown, please indicate. If space for supplemental information is needed, insert numbered footnote and provide brief supporting discussion in Section VI, Justification for Closure.

SITE CLOSURE REQUEST FORM

I. GENERAL INFORMATION

LPST ID No.: 93205 Facility ID No.: 0038825

Responsible Party: Department of the Air Force

Responsible Party Address: HQ AFMC, Kelly AFB City: San Antonio State: TX Zip: 78241

Facility Name: Building 2093, Kelly AFB, TX

Facility Street Address: 305 Tinker Dr.

Facility City: San Antonio, Texas County: Bexar

What is the current use of site? (indicate all that apply):
☐Residence[1] ☐School or Day Care center ☒Commercial/Industrial[1] ☐Recreational ☐Agricultural

What is the anticipated future use of the site? (indicate all that apply):
☐Residence[1] ☐School or Day Care center ☒Commercial/Industrial[1] ☐Recreational ☐Agricultural

Adjacent property use (indicate all that apply):
☐Residence[1] ☐School or Day Care Center ☒Commercial/Industrial[1] ☐Recreational ☐Agricultural

Distance to nearest off-site residence from property line: >0.5 miles.

Distance to nearest school or day care center from property line: >0.5 miles.

II. CLOSURE SCREENING INFORMATION

Based on the *Limited Site Assessment Report* form or the Risk-Based *Assessment Report Form* (TNRCC-0562), the site is currently a **Priority** 4.1 site. If the site priority has changed, list the other priorities that previously pertained to this site:

☐Yes ☒No Have non-aqueous phase liquids (NAPL) ever been present at this site (including tankpit observation wells)? If yes, is NAPL present now (thickness ≥0.1 feet)? [1] Yes [1] No Current thickness: _____ ft. If NAPL is currently present, stop here and do not submit this form for case closure. Initiate or continue activities necessary for the removal of all recoverable NAPL at the site.

☒Yes ☐No Were all soils, recovered contaminated groundwater, and any phase-separated hydrocarbons properly disposed of, treated, recycled or reused in accordance with TNRCC requirements? If No, stop here and do not submit this form. Provide a proposal (if the site is eligible for reimbursement) to properly dispose or otherwise manage the wastes/materials or, if the site is not eligible for reimbursement, provide documentation of proper disposition of the wastes.

☒Yes☐No Do contaminant concentrations show a consistent decreasing or low static trend? If No, is the contaminant plume increasing in size? ☐Yes ☒No If Yes, stop here, do not submit this form, and initiate activities to control plume migration.

[1] See definition in 30 TAC 334.202

III. RELEASE ABATEMENT/REMEDIATION

Date Release Discovered: June 27, 1989

Substance(s) released: *(check all that apply)* ☒Gasoline ☐Alcohol-blended fuel (Type and percentage of alcohol:_____)
☐Diesel ☐Used Oil [1] Jet Fuel (type:_____) ☐Aviation Gasoline ☐Other: *(be specific)*_____

Source of Release *(specify all that apply)*:
☒Spills/overfills ☒Piping leaks ☐Dispenser leaks ☒Tank corrosion [1] Other:_____

☒Yes ☐No Has a receptor survey been conducted?
☒Yes ☐No Has a water well inventory been conducted?

☐Yes ☒No Have vapor impacts to buildings or utility lines ever been associated with this release? If Yes, specify the measures taken to abate the impact and indicate the latest date that an impact was noted:

☐Yes ☒No Have subsurface utilities ever been affected with NAPL or vapors by this release? If Yes, indicate the latest date that an impact was noted:_____

If not already provided in *Release Determination Report Form* (TNRCC-0621), or if the information has changed since submittal of the *Release Determination Report*, indicate number of tanks currently and formerly located at this site (attach pages as necessary):

	Type (UST/AST)	Product Type	Size (approx. gal)	Date Removed from Service
Current:	N/A			
Former:	UST	gasoline	10,000	1991
	UST	gasoline	10,000	1991
	UST	gasoline	10,000	1991

☒Yes ☐No If the tanks were permanently removed from service, were native soil samples collected from beneath the tanks **and** the entire length of the piping? If No, explain why not:

☐Yes ☒No Was a new UST system installed? If Yes, indicate the date, number of tanks and their contents:

☐Yes ☒No Are there any open excavations at the site? If Yes, state size, location, purpose, and status for each of the excavations:_____

Type(s) of soil remediation and time periods the remediation method was operational *(indicate all that apply)*:
☒Excavation 2/6/95 to 4/21/95 *(dates)*, and
[1] Aboveground Bioremediation/Aeration _____ to _____ *(dates)*, or
[1] Thermal Treatment _____ to _____ *(dates)*, or
[1] Disposal 3/27/95 to 4/14/95 *(dates)*.
☐Soil Vapor Extraction _____ to _____ *(dates)*.
☐In-Situ Bioremediation _____ to _____ *(dates)*.
☐None

III. RELEASE ABATEMENT/REMEDIATION (Continued)

Type(s) of groundwater remediation and time periods the remediation method was operational *(indicate all that apply)*: N/A

☐Groundwater Pump and Treat _____ to _____ *(dates)*

☐Air Sparging/SVE _____ to _____ *(dates)*

☐In-Situ Bioremediation _____ to _____ *(dates)*

☐Other:_____ _____ to _____ *(dates)*

☐None

☒Yes ☐No Were copies of all receipts and manifests to document disposition of all wastes submitted to the TNRCC? If No, attach copies to this form.

Measured total volume of NAPL recovered: N/A gallons.

Estimated total volume of soil treated/removed: 2,715 cubic yards *(exclude soil cuttings removed from borings)*.

Estimated total volume of groundwater treated/removed: N/A gallons *(if known)*.

Estimated pounds of hydrocarbons removed or treated from soil *(if known)*: Not available

Estimated pounds of hydrocarbons removed or treated from groundwater *(if known)*: Not available

Estimated percent of total contaminants removed or treated *(if known)*: Not available

IV. SOIL DATA VALIDATION

Are there now affected surface soils (contamination exceeding health-based target concentrations) present within 2 feet below the ground surface? ☐Yes ☒No ☐Unknown

Type of surface cover over affected surface soil area:

☒Paved [☒Asphalt or ☐Concrete] Percent of affected soils covered? 100 ☐Unpaved

☐Other:_____

Is there public access to the uncovered affected surface soil area? ☐Yes ☒No

Total number of borings: 19 (including those completed as monitor wells)

☒Yes ☐No Was the vertical and horizontal extent of soil impacts defined (to the more stringent of health-based target or groundwater protective soil concentrations horizontally and to groundwater or nondetect vertically) by the borings?

☐Yes ☒No Are shallow (0-15 feet below ground surface) soils affected (contaminant levels exceed health-based target concentrations) on adjacent properties (including right-of-way properties).

☒Yes ☐No Were all soil sample collection, handling, transport, and analytical procedures conducted in accordance with TNRCC and EPA requirements? If No, provide justification:_____

MAXIMUM SOIL CONCENTRATION LEVELS

Soil Contaminants	Sample Date	Sample Location	Depth (in feet below ground surface)	Analytical Method	Maximum Concentration* (mg/kg)	Target Cleanup Goals** (indicate source of target cleanup goals: 1990 or 1994 [Plan A or B] guidance) a/
Benzene	4/14/95	G95001203	20	USEPA 8020	2.7	0.74
Toluene	4/14/95	G95001203	20	USEPA 8020	32	503
Ethylbenzene	4/14/95	G95001203	20	USEPA 8020	14	835
Total Xylenes	4/14/95	G95001203	20	USEPA 8020	66	968
Total BTEX	4/14/95	G95001203	20	USEPA 8020	115	--
TPH	4/14/95	G95001203	20	USEPA 418.1	31	--
Other Total Lead	4/14/95	G95001203	20	USEPA 7420	23	NA (400) b/
Other_____						

* **Enter maximum soil analytical results for soils remaining beneath the site (take into account all available data, including information obtained during the release determination (tank removal from service, minimal site assessment, etc)).**

** **If Plan A cleanup goals were used, provide the potential groundwater beneficial use category and a justification of how it was determined in Section VI.**

1990 cleanup goals may be used only if all activities necessary to meet those goals were completed by November 8, 1995.

a/ **Category II Plan A Groundwater Protective (mg/kg), TNRCC, 1994.**

b/ **NA (400) = TNRCC criteria not available. A screening level of 400 mg/kg is presented based on Revised Interim Soil Lead Guidance for CERCLA Site and RCRA Corrective Action Facilities (USEPA, 1994)**

V. GROUNDWATER DATA VALIDATION

Is groundwater at the site impacted? ☒Yes ☐No

Did the assessment document that groundwater was not impacted? ☐Yes ☐No If No or unsure, provide justification for not determining whether there is a groundwater impact: N/A

Total number of monitoring wells installed: 12

Will any of the remaining wells be used in the future? ☒Yes ☐No If Yes, specify exactly which well(s) will be used:

REQUESTED KELLY AIR FORCE BASE INPUT

If No, they must be plugged in accordance with 30 TAC Chapter 338 **after** obtaining approval for site closure. **Do not** plug the wells until you receive concurrence on site closure. Costs of well plugging may be allowable for reimbursement if all eligibility requirements are met and if the wells were installed under the direction of the TNRCC specifically to address the confirmed release at the site. Provide a proposal with this form (if the site is eligible for reimbursement) for costs of the well plugging.

Measured total dissolved solids (TDS) concentration in groundwater: 660-1,140 mg/l. From which monitor well(s) was/were the sample(s) collected? KY024 MW010; MW009; MW008; MW004; MW007; MW011; MW006

Measured groundwater yield at the site: 216 gallons/day (as determined from well adequately screened in the impacted aquifer). ☐Not determined.

Measured groundwater depth at the site ranges between 5 and 37 feet below the top of well casing.

Time period of groundwater monitoring at the site *(dates)*: 9/89 to 11/97.

Total number of groundwater monitoring events: 14.

What type of aquifer is impacted? (unconfined, confined, semi-confined): unconfined.

Distance from maximum plume concentration point to nearest existing downgradient well location (not monitor well): >0.5 mile _____ direction (Input ">0.5 mile" if there is no well within 0.5 mile downgradient)

Are any water supply wells impacted or immediately threatened? ☐Yes ☒No
If Yes, specify type of well: ☐Drinking water ☐Non-drinking water

Are there any existing water wells located within the area of impacted groundwater? ☐Yes ☒No
If Yes, specify type of well: ☐Drinking water ☐Non-drinking water

Has surface water been affected? ☐Yes ☒No

Will the groundwater contaminants likely discharge to a surface water body? ☐Yes ☒No

What is the potential impact of affected groundwater discharge on surface water?
☐Current impact ☐Discharges within 500 ft. ☐Discharges within 500 to 0.25 miles
☒No potential impact

☒Yes ☐No Were groundwater sample collection, handling, transport, and analytical procedures conducted and documented in accordance with TNRCC requirements? If no, provide justification:

V. GROUNDWATER DATA VALIDATION (Continued)

☒Yes ☐No Is the extent of groundwater contamination defined (to MCL concentrations)? If No, provide justification for not defining the plume:

☒Yes ☐No Have groundwater impacts from this release been detected on adjacent properties? If No, is off-site migration probable? ☐ Yes ☐ No Is there documentation that off-site migration has **not** occurred (sample results from off-site sampling point)? ☐ Yes ☐ No

☒Yes ☐No Was the static groundwater level above the top of the well screen in any monitor wells during any of the last 4 monitoring events? If Yes, provide a statement of validity regarding these samples:
The low permeability of the soils preclude MWs screened across the water table from producing an adequate amount of water for sample collection. When samples were able to be collected in these wells, the shallow contaminant concentrations were relatively low compared to the deeper wells (Brown and Root, 1993).

☐Yes ☒No Have groundwater samples from all monitor wells met the target cleanup goals for the last four consecutive sampling events?

MAXIMUM GROUNDWATER CONCENTRATIONS

Groundwater Contaminants	Sample Date	Sample Location	Laboratory Method	Maximum Concentration* (mg/l)	Target Cleanup Goals** *(indicate source of target cleanup goals: 1990 or 1994 [Plan A or B] guidance)* a/
Benzene	11/13/97	KY024 MW004	USEPA 8020	2.200	0.0294
Toluene	3/18/97	KY024 MW004	USEPA 8020	0.080	7.3
Ethylbenzene	11/13/97	KY024 MW004	USEPA 8020	0.4	3.65
Total Xylenes	11/13/97	KY024 MW004	USEPA 8020	0.18	73
Total BTEX	11/13/97	KY024 MW004	USEPA 8020	2.81	--
TPH	--	--	--		--
Other Lead (total)	11/13/97	KY024 MW004	USEPA 7421	0.0076	NA b/
Other MTBE	11/13/97	KY024 MW004	USEPA 8020	3.3	NA

* Enter maximum groundwater analytical results from the most recent 12 months of monitoring.

** 1990 cleanup goals may be used only if all activities necessary to meet those goals were completed by November 8, 1995.

a/ Category II Plan A Groundwater Concentration (mg/L) (TNRCC, 1994).

b/ NA = TNRCC criteria not avabilable.

VI. JUSTIFICATION FOR CLOSURE

Please provide a brief summary supporting this request for site closure, including footnoted discussions for the above entries as necessary. **Include discussions providing necessary justifications for any site conditions which deviate from the specific requirements of TNRCC rules and policies, including the document *Risk-Based Corrective Action for Leaking Storage Tank Sites*.** Provide documentation to justify case closure, including information which addresses the potential for future exposure, the existence of impervious cover or other actions which may prevent exposure or limit infiltration, the absence of receptors, etc.

See Attachment 1

LPST ID No. 93205

VII. REPORT PREPARATION

Based on the results of the site investigation and the additional information presented herein, I certify that the site investigation activities performed either by me, or under my direct supervision, including subcontracted work, were conducted in accordance with accepted industry standards/practices and further, that all such tasks were conducted in compliance with applicable TNRCC published rules, guidelines and the laws of the State of Texas. I have reviewed the information included within this report, and consider it to be complete, accurate and representative of the conditions discovered during the site investigation. I acknowledge that if I intentionally or knowingly make false statements, representations, or certifications in this report, I may be subject to administrative, civil, and/or criminal penalties. **I certify that the site has met all requirements for closure and that closure is appropriate.**

Project Manager: Brian Vanderglas CAPM No.: 00758 Expiration date: 8/10/98

Company: Parsons Engineering Science, Inc.

Address: 800 Centre Park Dr., Suite 200 City: Austin State: TX Zip: 78754

Telephone No.: (512) 719-6000 Fax No.: (512) 719-6099

Signature: Brian Vanderglas Date: 7/16/98

By my signature affixed below, I certify that I am the duly authorized representative of the Correction Action Specialist named and that I have personally reviewed the site investigation results and other relevant information presented herein and considered them to be in accordance with accepted standards/practices and in compliance with the applicable TNRCC published rules, guidelines and the laws of the State of Texas. Further, that the information presented herein is considered complete, accurate and representative of the conditions discovered during the site investigation. I acknowledge that if I intentionally or knowingly make false statements, representations, or certifications in this report, I may be subject to administrative, civil, and/or criminal penalties. **I certify that the site has met all requirements for closure and that closure is appropriate.**

Corrective Action Specialist: Brian Vanderglas CAS No.: 00101 Expiration date: 10/16/98

Company: Parsons Engineering Science, Inc.

Address: 800 Centre Park Dr., Suite 200 City: Austin State: TX Zip: 78754

Telephone No: (512) 719-6000 Fax No.: (512) 719-6099

Signature: Brian Vanderglas Date: 7/16/98

By my signature affixed below, I certify that I have reviewed this report for accuracy and completeness of information regarding points of contact and the facility and storage tank system history and status. I acknowledge that if I intentionally or knowingly make false statements, representations, or certifications in this report related to the contact information, and the facility and storage tank system history and status information, I may be subject to administrative, civil, and/or criminal penalties. I attest that I have reviewed this report for accuracy and completeness. I understand that I am responsible for addressing this matter.
I certify that the site has met all requirements for closure and that closure is appropriate.

Name of Responsible Party contact: _____

Telephone No.: _____ Fax No.: _____

Signature: _____ Date: _____

THE FOLLOWING ITEMS MUST BE SUBMITTED WITH THIS FORM IF NOT PREVIOUSLY SUBMITTED:

- A site map illustrating the locations of the entire UST and/or AST system (including piping, dispensers, observation wells, etc.), all soil borings and monitoring wells and all other samplinifests or other waste receipts, and any other documents necessary for case closure.

ATTACHMENT 1

JUSTIFICATION FOR CLOSURE

SECTION VI
TNRCC PSTD LPST *SITE CLOSURE REQUEST FORM*

FINAL

JUSTIFICATION FOR CLOSURE FOR FORMER BUILDING 2093 GAS STATION, KELLY AFB, TEXAS

AETC Contract No. F41689-96-D-0710
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Prepared for

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
TECHNOLOGY TRANSFER DIVISION
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SA-ALC/EMRO
KELLY AIR FORCE BASE, TEXAS

July 1998

Prepared by

PARSONS ENGINEERING SCIENCE, INC.
1700 Broadway, Suite 900
Denver, Colorado 80209

LIST OF EXHIBITS

SECTION VI

Justification for closure based on the Texas Natural Resource Conservation Commission (TNRCC) Interoffice Memorandum *Process for Closure Evaluation of Petroleum Hydrocarbon LPST Sites Exceeding Target Concentrations* (February, 1997) is provide herein. This documentation fulfills the requirements of Section VI of the TNRCC Petroleum Storage Tank Division (PSTD) LPST *Site Closure Request Form* (TNRCC-0028). The work is being performed by Parsons Engineering Science, Inc. (Parsons ES) for the Air Force Center for Environmental Excellence, Technology Transfer Division (AFCEE/ERT), under Air Education and Training Command (AETC) Contract No. F41689-96-D-0710, Order No. 5015. This report is being submitted in lieu of a TNRCC Plan A Report because the existing data supports closure as presented in Section VI.

Historic site documents which aid in this justification include:

- *Texas Water Commission Product Storage Tanks Final Site Closure Report* (Ogden, 1995);
- *Texas Water Commission Limited Site Assessment Report Form* (EA, 1995); and
- Numerous annual groundwater monitoring reports.

REGULATORY REQUIREMENTS

The Former Building 2093 site is currently regulated by the Petroleum Storage Tank (PST) Division of the TNRCC. The TNRCC designation for this site is LPST ID No. 93205. Published guidance entitled *Risk-Based Corrective Action for Leaking Underground Storage Tank (UST) Sites* (TNRCC, 1994) contains information regarding the risk-based corrective action process and the establishment of remediation targets for sites regulated by the PST Division. Additional guidance regarding case closure criteria at low-risk leaking UST sites became available in February 1997 (TNRCC, 1997). In summary, the guidance indicates that site closure is appropriate if the following criteria are met:

1. The groundwater contaminant plume is stable or declining in magnitude and/or size. Plume stability can be demonstrated by at least four groundwater monitoring events. In addition, natural attenuation indicators can be used to demonstrate trends suggesting natural attenuation is occurring and is likely to continue to occur which would lead to declining contaminant concentrations. This is detailed in the TNRCC Interoffice Memorandum *Interim Guidance: Monitoring Natural Attenuation for Verification of Groundwater Plume Stability* (April, 1997); and

2. Current or future exposure potential is low such as typical Priority 4.1 and 4.2 sites. This can be demonstrated by developing a conceptual site model which details the potential for current and future exposures. To aid in this closure process, the TNRCC has developed a series of decision flow charts which should be used by owner/operators to evaluate groundwater and

exposure pathways. Institutional controls can be used to restrict exposure potential (e.g., no groundwater utilization) and still proceed to closure. These have been included as Figures 1 through 3. Each has been annotated with site-specific justification which leads the site to closure.

If the above two criteria can be met, closure of the site may be obtained by completing a *Leaking Petroleum Storage Tank (LPST) Closure Request Form* (TNRCC, 1996).

ADDITIONAL SITE INFORMATION

Information regarding the site which has not been submitted previously to the TNRCC is included as Exhibits A though Q. This work was performed as part of an AFCEE demonstration project evaluating risk-based investigation and closure of low-risk sites. The work was performed in accordance with the *Final Work Plan for the Risk-Based Investigation and Closure of the Former Building 2093 Gas Station, Kelly Air Force Base, Texas* (Parsons ES, 1997). The data gathered during this demonstration is used to augment data previously collected at Former Building 2093 to support closure. Data collection activities included:

- The installation of additional groundwater monitoring wells (KY024MW068, KY024MW069, and KY024MW070) and collection of geochemical and contaminant data from these wells and selected preexisting site monitoring wells;
- Soil sampling to support the natural attenuation evaluation of the dissolved groundwater plume (total organic carbon measurements);
- Soil gas sampling in the immediate vicinity of Building 2075; and
- Collection of site-specific hydraulic conductivity data (slug tests).

EXPOSURE POTENTIAL

Based on the Conceptual Site Model (CSM) for Former Building 2093, air, soil, and shallow groundwater represent the potentially affected physical media at the Former Building 2093 Gas Station. Surface water, while occasionally present as storm water runoff in the shallow drainage swales, is not thought to have been affected by site petroleum contamination. The subsurface location of historic fuel releases, the excavation of surface and subsurface source area soils, and the depth to groundwater as compared to the shallow drainage swale depth, has prevented surface water from being impacted.

Kelly AFB is currently undergoing Base closure activities. Base personnel continue to work at the site, but it is assumed that the Former Building 2093 site will continue to be used for industrial/commercial activities in the future. Based on foreseeable future site activities, no change is expected in potential receptors at the site. Surrounding off-base land use is primarily commercial; however, some agricultural and/or residential land use is present south of Military Drive and south of the Base.

Based on these land use assumptions, commercial worker populations and construction worker populations are the only current or foreseeable future onsite human receptors. Due to the occasional shallow depth to groundwater (5 to 10 feet bgs), construction or maintenance workers performing intrusive site activities could be exposed to impacted groundwater, subsurface soils, and to air potentially affected by chemicals volatilizing from subsurface media. In addition, workers performing nonintrusive tasks at the site or located within the new Building 2075 could be exposed to volatile organics from the subsurface soil gas. However, maximum detected benzene, toluene, ethylbenzene, and xylenes (BTEX) concentrations in soil and groundwater are below TNRCC (1997) target concentrations for construction worker exposures. To address possible vapor inhalation by construction workers, one soil gas sample was collected from the area adjacent to Building 2093 (approximately 2 to 3 feet bgs) at the location of the most contaminated remaining soils (i.e., worst case scenario) (Exhibit B). Soil gas concentrations of BTEX were at least two orders-of-magnitude below OSHA time-weighted average (TWA) Permissible Exposure Levels (PELs) developed to be protective of on-site workers (NIOSH, 1994). Although this exposure pathway is potentially complete, the data indicate that exposure risk is minimal.

No exposure pathways to current off site receptors are believed to be completed, nor are future off site receptor pathways likely to be completed. Water supply wells which are located within 0.5 mile of the site are screened in the Edwards Aquifer approximately 1,000 feet bgs, and are adequately protected from the impacted shallow aquifer by the large thickness of low-permeability sediments separating the two zones (Navarro Clay approximately 400 feet thick).

Although numerous plant and wildlife species could be occupying areas on and near Kelly AFB, the absence of exposure pathways (e.g., no surface water impact and no shallow soils exposure due to pavement cover) indicates that no ecological receptors are likely to be exposed to contaminants.

Based on this evaluation of current and future receptors, the potential risk of exposure is minimal. This is also illustrated in the TNRCC decision flow charts which have been annotated with site-specific information (Figures 1 through 3).

PLUME STABILITY

Fourteen rounds of groundwater sampling has been completed at Former Building 2093 between September 1989 and November 1997. The previous groundwater sampling events have indicated a contaminant plume which is not increasing in areal extent and is exhibiting a low static trend (i.e., groundwater concentrations not increasing significantly). Two monitoring wells near the source area (KY024MW004 and KY024MW010) have consistently exhibited benzene concentrations above TNRCC Plan A Category II groundwater criteria. The most recent groundwater sampling event verifies the previous data (Exhibits E). In addition, natural attenuation parameters collected during the most recent field event exhibit trends associated with a plume which is being naturally degraded (Exhibits I though O). Because the source has been removed (i.e., excavation of contaminated soils), this degradation will continue to decrease the concentrations of dissolved contaminants. In addition, assimilative capacity calculations provide in Exhibit P suggest that the shallow aquifer has the

biological capacity to attenuate the existing contamination (see Exhibit P for explanation of assimilative capacity). In addition, the low permeability soil present at Former Building 2093 (Exhibit D - Aquifer Test Data) has minimized plume migration away from the source area. These observations are supported by BIOSCREEN® Modeling (Exhibit Q) which was performed to evaluate contaminant (specifically benzene) migration. Modeling results indicate that benzene will not migrate past the most downgradient well (KY024MW070) at levels above TNRCC criteria. In addition, the model indicates that benzene concentrations should fall below TNRCC criteria within 10 years.

CONCLUSION

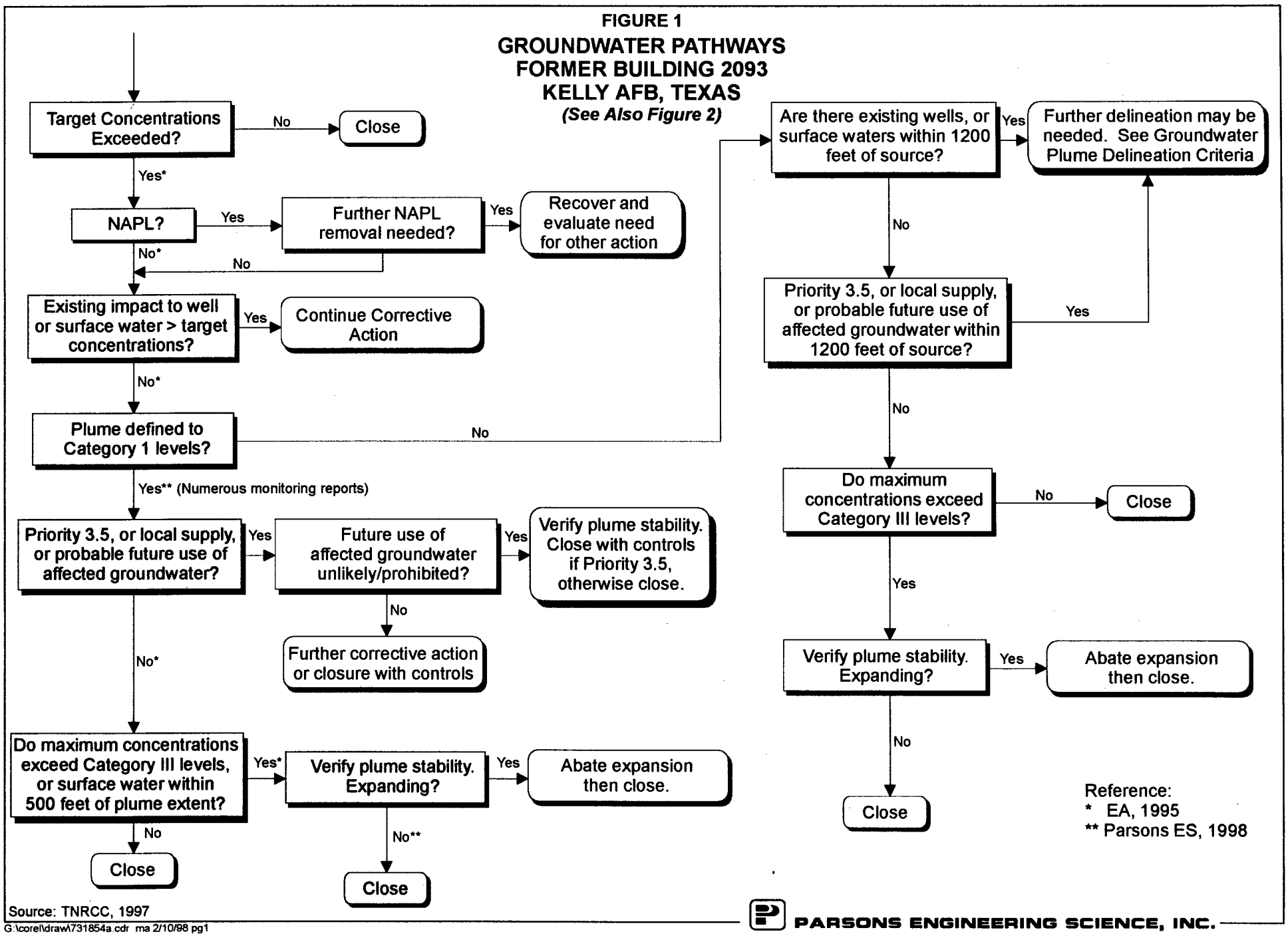
Given the low potential for current or future exposure to site contaminants, the historical groundwater data which indicates a contaminant plume that is not increasing in areal extent, and the strong geochemical evidence that natural attenuation is occurring at the site, Former Building 2093 is a candidate for immediate closure according to TNRCC guidance. Given the fact that dissolved benzene concentrations in groundwater remain above TNRCC Plan A Category II criteria near the source area, Kelly AFB proposes to restrict use of the shallow groundwater at the site.

FIGURE 1

FIGURE 1

GROUNDWATER PATHWAYS
FORMER BUILDING 2093
KELLY AFB, TEXAS

(See Also Figure 2)



Source: TNRCC, 1997

G:\corel\draw\731854a.cdr ma 2/10/98 pg1

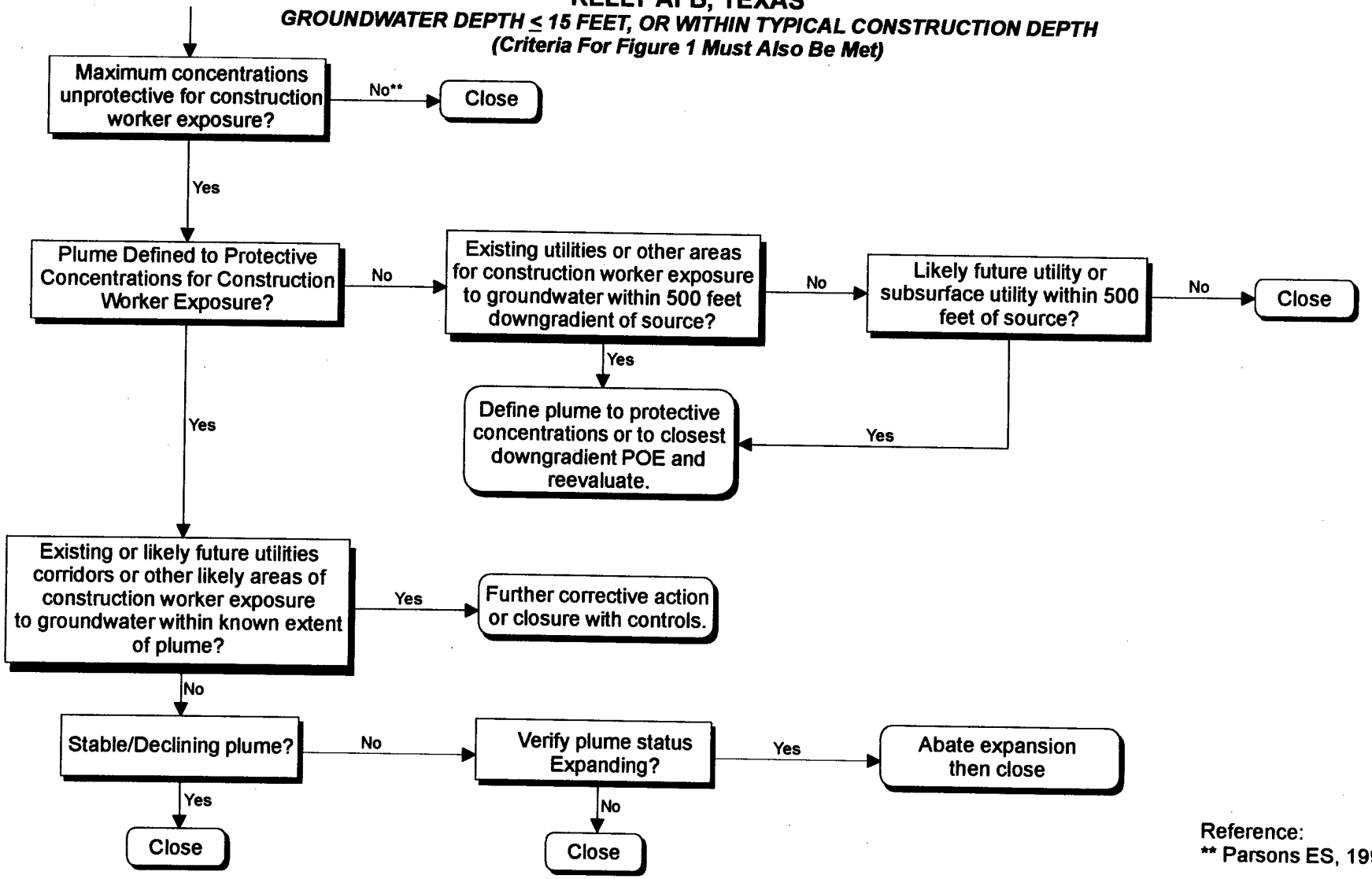
PARSONS ENGINEERING SCIENCE, INC.

FIGURE 2

FIGURE 2

GROUNDWATER PATHWAYS
FORMER BUILDING 2093
KELLY AFB, TEXAS

GROUNDWATER DEPTH ≤ 15 FEET, OR WITHIN TYPICAL CONSTRUCTION DEPTH
(Criteria For Figure 1 Must Also Be Met)



Reference:
** Parsons ES, 1998

Source: TNRCC, 1997

G:\corel\draw\731854a.cdr ma 2/10/98 pg2

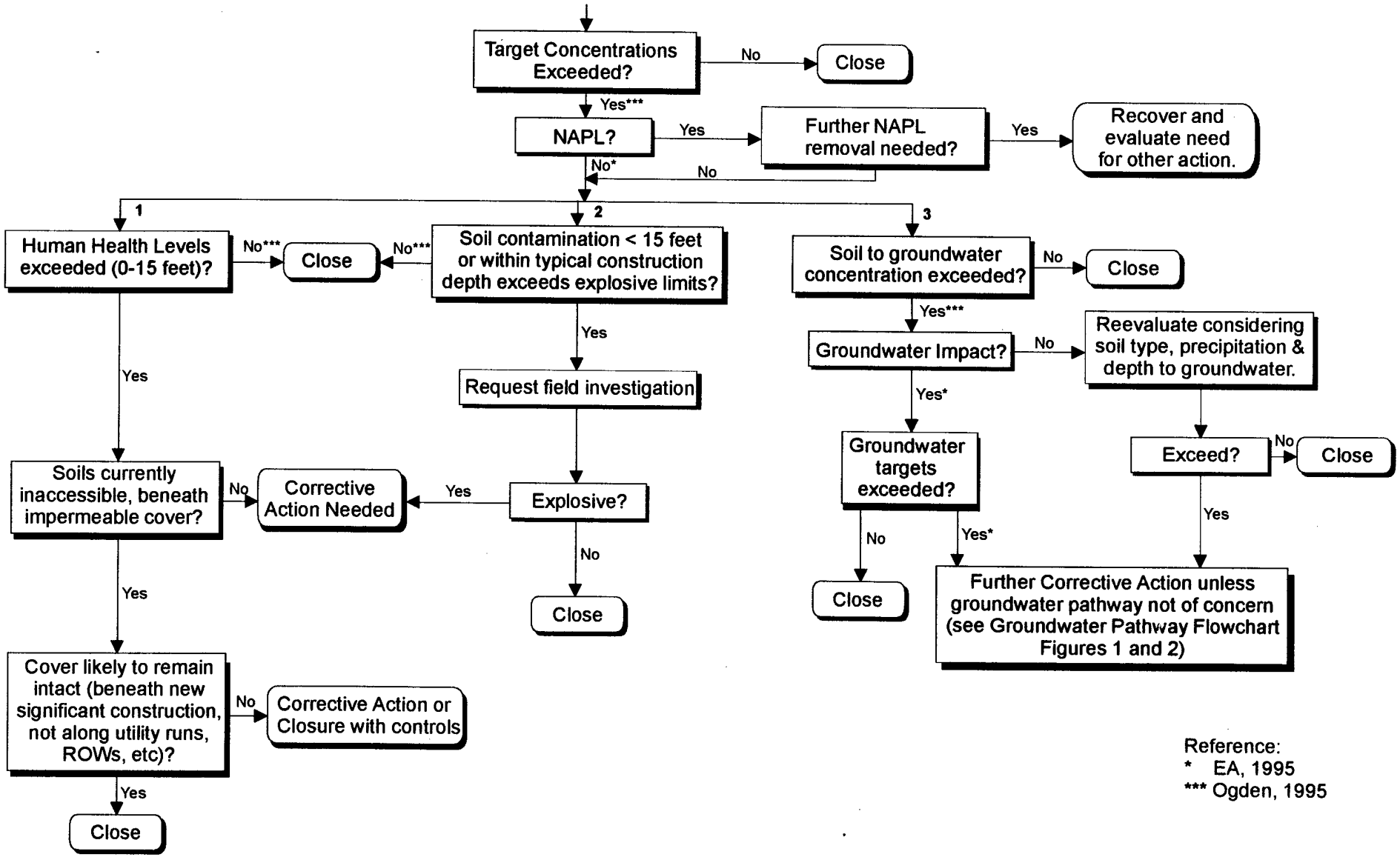
PARSONS ENGINEERING SCIENCE, INC.

FIGURE 3

FIGURE 3

SOILS PATHWAYS
FORMER BUILDING 2093
KELLY AFB, TEXAS

EVALUATE ALL THREE PATHWAYS



Reference:
* EA, 1995
*** Ogden, 1995

Source: TNRCC, 1997

G:\corel\draw\731854a.cdr ma 2/10/98 pg3

PARSONS ENGINEERING SCIENCE, INC.

Validation Flags

The following definitions provide explanations of the USEPA (1994a and 1994b) qualifiers assigned to analytical results during data validation. The data qualifiers described were applied to both inorganic and organic results.

U - The analyte was analyzed for and is not present above the practical quantitation limit (PQL).

J - The analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the environmental sample. The data should be considered as a basis for decision-making and are usable for many purposes.

J1 - The analyte is qualified as an estimated value solely because it is greater than the method detection limit (MDL) and less than the PQL indicating no laboratory quality issues.

UJ - The analyte analyzed for was not present above the reported PQL. The associated numerical value may not accurately or precisely represent the concentration necessary to detect the analyte in the sample.

R - The data are rejected as unusable for all purposes. This analyte was analyzed for, but the presence or absence of the analyte was not verified. Resampling and reanalysis are necessary to confirm the presence or absence of the analyte.

EXHIBIT A

SITE LAYOUT

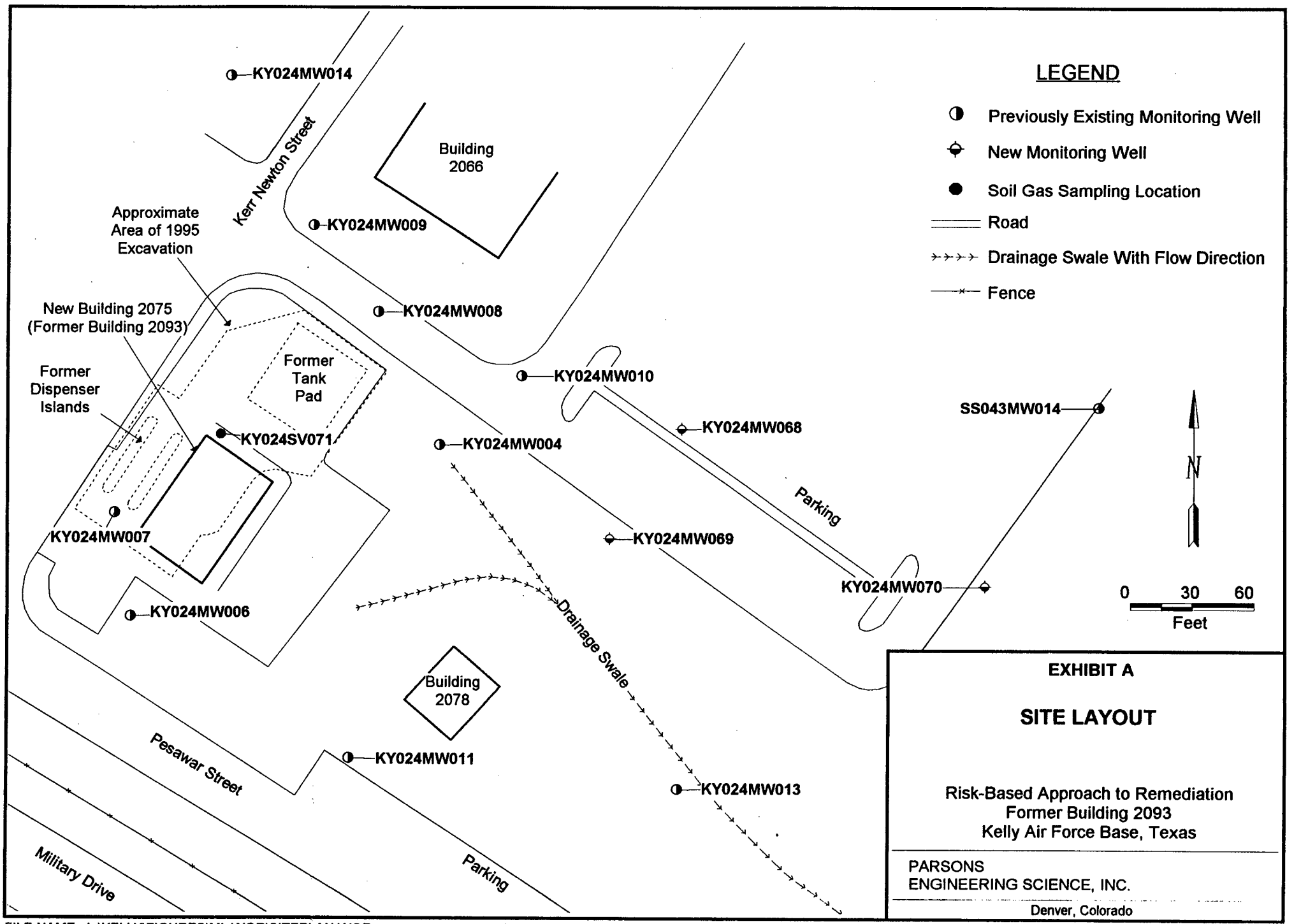


EXHIBIT A

SITE LAYOUT

Risk-Based Approach to Remediation
Former Building 2093
Kelly Air Force Base, Texas

PARSONS
ENGINEERING SCIENCE, INC.
Denver, Colorado

FILE NAME: I:\KELLY\FIGURES\MI_WOR\SITEPLAN.WOR DATE: 02/11/98 TIME: 1018

EXHIBIT B

SOIL GAS RESULTS (11/97)

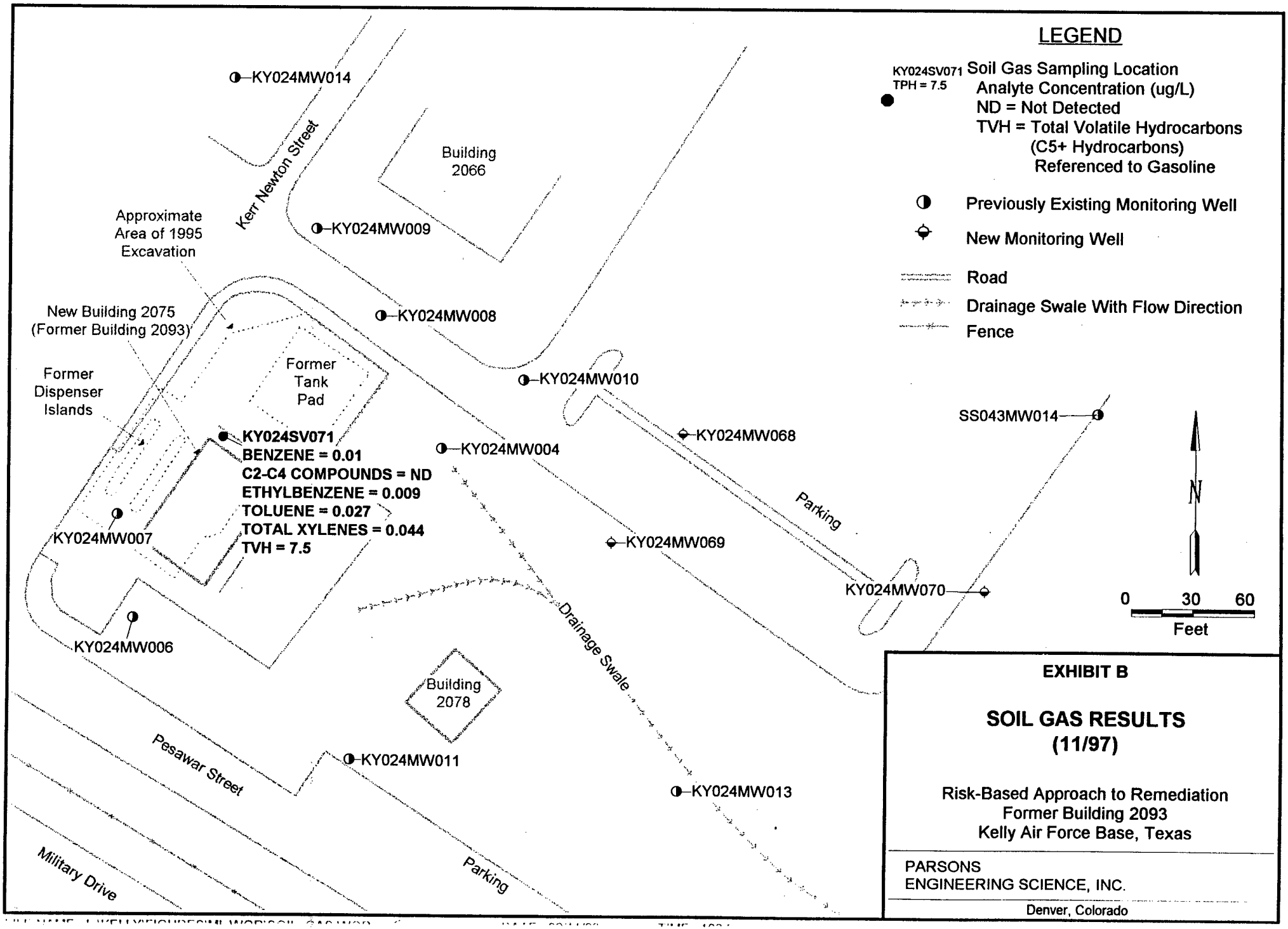

LEGEND
KY024SV071 Soil Gas Sampling Location
TPH = 7.5 Analyte Concentration (ug/L)
ND = Not Detected
TVH = Total Volatile Hydrocarbons
(C5+ Hydrocarbons)
Referenced to Gasoline
Previously Existing Monitoring Well
New Monitoring Well
Road
Drainage Swale With Flow Direction
Fence
KY024MW014
Kerr Newton Street
Building 2066
KY024MW009
Approximate Area of 1995 Excavation
New Building 2075 (Former Building 2093)
KY024MW008
Former Tank Pad
Former Dispenser Islands
KY024MW010
SS043MW014
KY024MW068
KY024SV071
BENZENE = 0.01
C2-C4 COMPOUNDS = ND
ETHYLBENZENE = 0.009
TOLUENE = 0.027
TOTAL XYLENES = 0.044
TVH = 7.5
KY024MW004
Parking
KY024MW007
KY024MW069
KY024MW070
Drainage Swale
KY024MW006
Building 2078
Pesawar Street
KY024MW011
KY024MW013
Military Drive
Parking
N
0 30 60
Feet
EXHIBIT B
SOIL GAS RESULTS
(11/97)
Risk-Based Approach to Remediation
Former Building 2093
Kelly Air Force Base, Texas
PARSONS
ENGINEERING SCIENCE, INC.
Denver, Colorado

EXHIBIT C

GROUNDWATER ELEVATION (1/6/98)

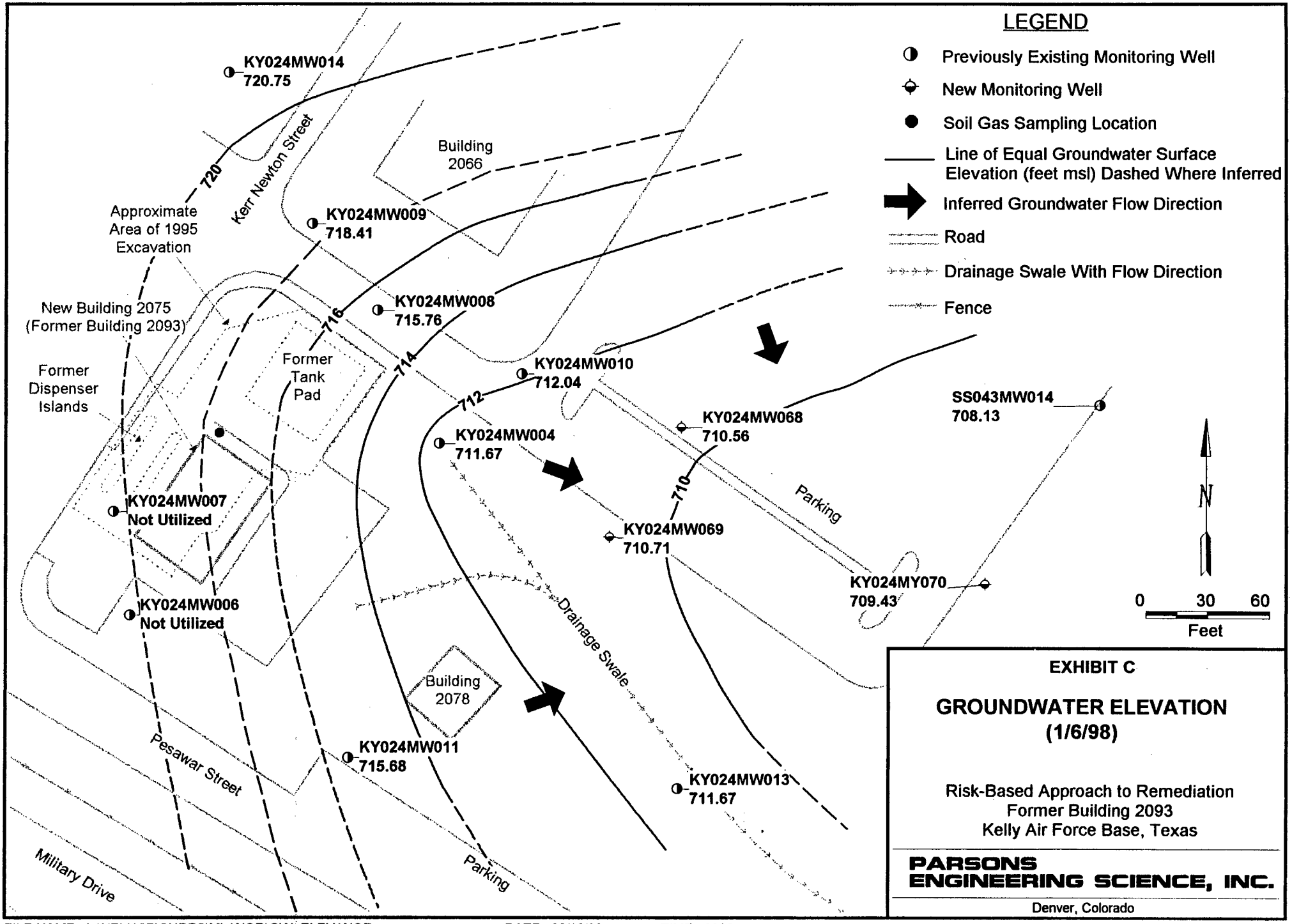


EXHIBIT C

GROUNDWATER ELEVATION (1/6/98)

Risk-Based Approach to Remediation
Former Building 2093
Kelly Air Force Base, Texas

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

FILE NAME: L:\KELLY\FIGURES\MI WOR\GW ELEV.WOR DATE: 02/13/98 TIME: 0926

EXHIBIT D

AQUIFER PROPERTIES (11/97)

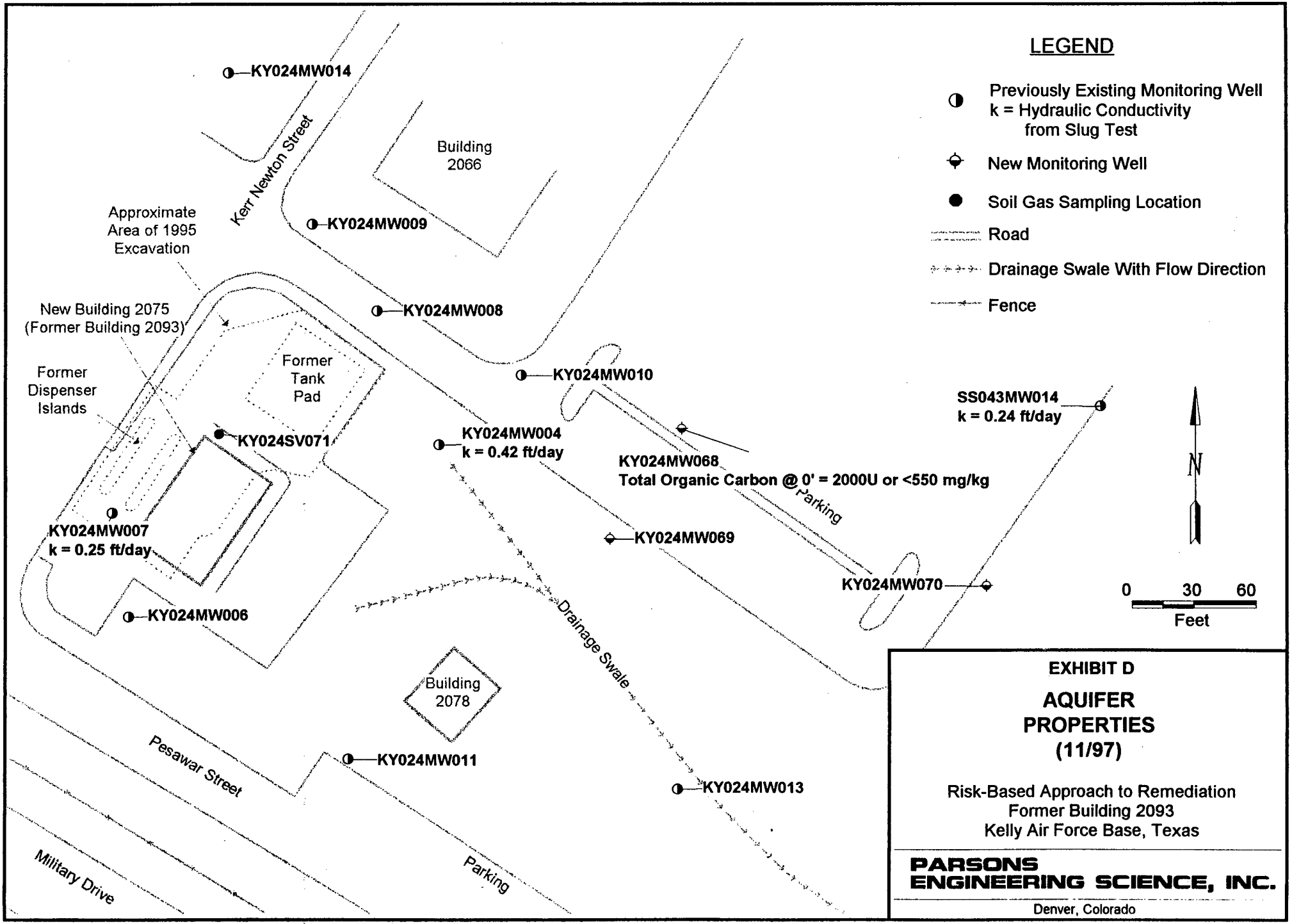


EXHIBIT D

AQUIFER PROPERTIES (11/97)

Risk-Based Approach to Remediation
Former Building 2093
Kelly Air Force Base, Texas

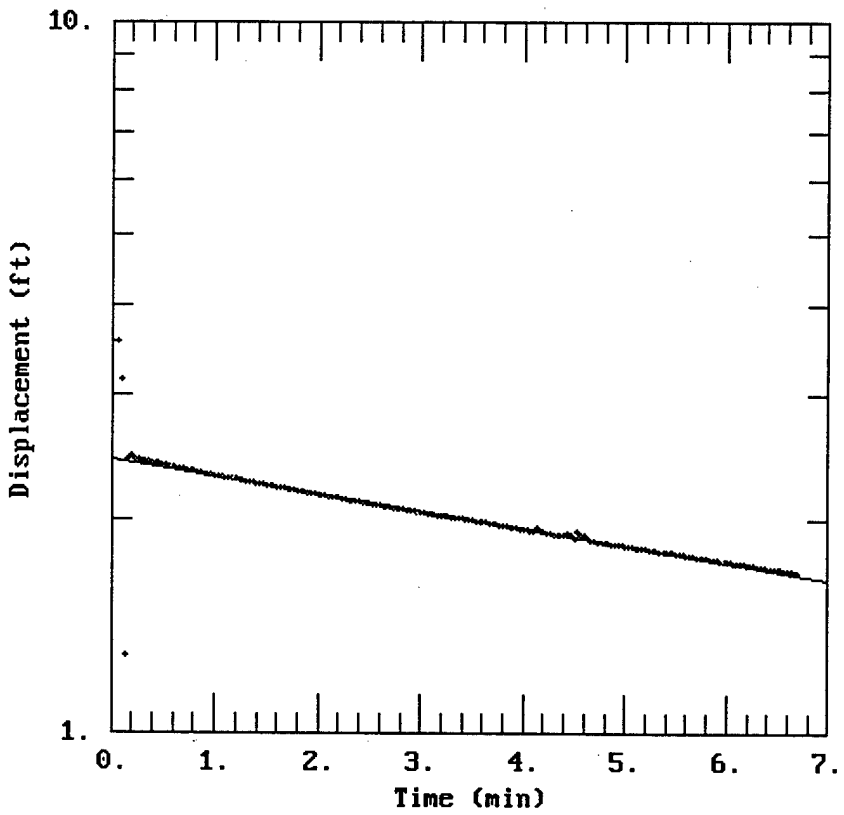
PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

FILE NAME: L:\KELLY\FIGURES\ML_WOR\SLUGTEST.WOR DATE: 02/13/98 TIME: 1025

CLIENT: AFCEE	COMPANY: Parsons Engineering Science
LOCATION: Kelly AFB - Building 2093	PROJECT: 731854

FALLING HEAD - KY024MW004



DATA SET:
FH1KY004.DAT
01/26/98

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 3.557 ft
r_c= 0.0833 ft
r_w= 0.3333 ft
L = 10. ft
b = 28.52 ft
H = 28.52 ft

PARAMETER ESTIMATES:
K = 0.0003432 ft/min
y0 = 2.434 ft

AQTESOLV

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A Q T E S O L V   R E S U L T S

Version 2.0

Developed by Glenn M. Duffield

01/26/98 15:15:47

==

TEST DESCRIPTION

ata set........... FH1KY004.DAT
utput file........ FH1KY004.OUT
ata set title..... FALLING HEAD - KY024MW004
ompany............ Parsons Engineering Science
roject............ 731854
lient............. AFCEE
ocation........... Kelly AFB - Building 2093
est date.......... 11/17/97
Test well......... KY024MW004

nits of Measurement
Length.......... ft
Time............ min

est Well Data
Initial displacement in well..... 3.557
Radius of well casing............ 0.0833
Radius of wellbore............... 0.3333
Aquifer saturated thickness...... 28.52
Well screen length............... 10
Static height of water in well... 28.52
Gravel pack porosity............. 0.3
Effective well casing radius..... 0.1954
Effective wellbore radius........ 0.3333
Log(Re/Rw)....................... 3.196
Constants A, B and C............. 0.000 , 0.000, 1.969
No. of observations.............. 200

==

ANALYTICAL METHOD

ouwer-Rice (Unconfined Aquifer Slug Test)

==

RESULTS FROM VISUAL CURVE MATCHING

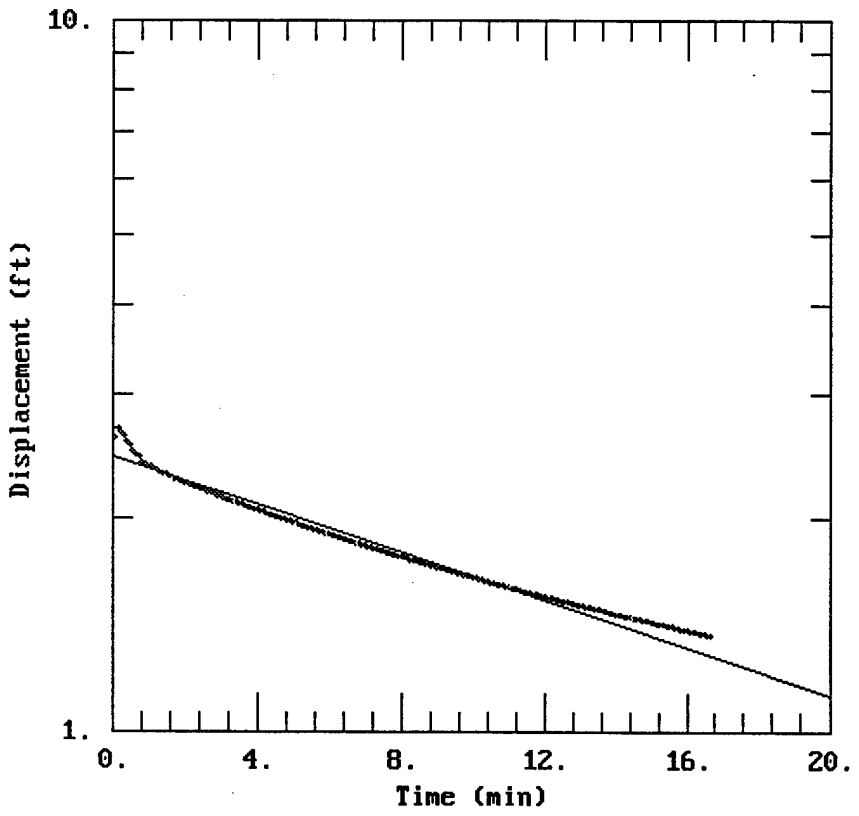
ISUAL MATCH PARAMETER ESTIMATES

	Estimate
K =	3.4316E-004 ft/min
y0 =	2.4336E+000 ft

<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>

CLIENT: AFCEE	COMPANY: Parsons Engineering Science
LOCATION: Kelly AFB - Building 2093	PROJECT: 731854

RISING HEAD TEST - KY024MW004



DATA SET:
RH1KY004.DAT
01/26/98

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 2.675 ft
r_c= 0.0833 ft
r_w= 0.3333 ft
L = 10. ft
b = 28.52 ft
H = 28.52 ft

PARAMETER ESTIMATES:
K = 0.000237 ft/min
y0 = 2.443 ft

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Version 2.0

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11/26/98 14:35:19

TEST DESCRIPTION

Data set..... RH1KY004.DAT
Output file..... RH1KY004.OUT
Data set title..... RISING HEAD TEST - KY024MW004
Company..... Parsons Engineering Science
Project..... 731854
Client..... AFCEE
Location..... Kelly AFB - Building 2093
Test date..... 11/17/97
Test well..... KY024MW004

Units of Measurement
Length..... ft
Time..... min

Test Well Data
Initial displacement in well..... 2.675
Radius of well casing..... 0.0833
Radius of wellbore..... 0.3333
Aquifer saturated thickness..... 28.52
Well screen length..... 10
Static height of water in well... 28.52
Gravel pack porosity..... 0.3
Effective well casing radius..... 0.1954
Effective wellbore radius..... 0.3333
Log(Re/Rw)..... 3.196
Constants A, B and C..... 0.000 , 0.000, 1.969
No. of observations..... 200

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

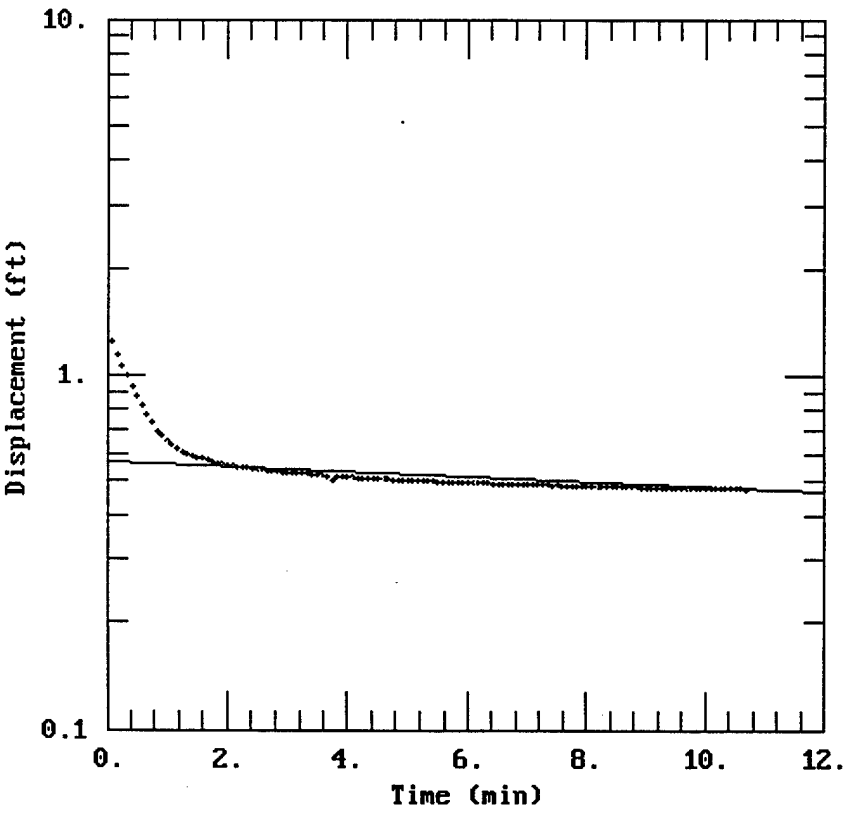
RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

	Estimate
K =	2.3703E-004 ft/min
y0 =	2.4428E+000 ft

CLIENT: AFCEE	COMPANY: PARSONS ENGINEERING SCIENCE
LOCATION: KELLY AFB	PROJECT: 731854

RISING HEAD TEST - KY024MW007



DATA SET:
RH1KY007.DAT
01/26/98

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 1.241 ft
r_c= 0.0833 ft
r_w= 0.3333 ft
L = 5.15 ft
b = 5.15 ft
H = 5.15 ft

PARAMETER ESTIMATES:
K = 0.0001273 ft/min
y0 = 0.5703 ft

AQTESOLV

```
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                        A Q T E S O L V   R E S U L T S
                                  Version 2.0

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11/26/98                                                                 13:03:01
==================================================================================
                                TEST DESCRIPTION

Data set........... RH1KY007.DAT
Output file........ RH1KY007.OUT
Data set title..... RISING HEAD TEST - KY024MW007
Company............ PARSONS ENGINEERING SCIENCE
Project............ 731854
Client............. AFCEE
Location........... KELLY AFB
Test date.......... 11-17-97
Test well.......... KY024MW007

Units of Measurement
   Length.......... ft
   Time............ min

Test Well Data
   Initial displacement in well..... 1.241
   Radius of well casing............ 0.0833
   Radius of wellbore............... 0.3333
   Aquifer saturated thickness...... 5.15
   Well screen length............... 5.15
   Static height of water in well... 5.15
   Gravel pack porosity............. 0.3
   Effective well casing radius..... 0.1954
   Effective wellbore radius........ 0.3333
   Log(Re/Rw)....................... 2.001
   Constants A, B and C............. 0.000 ,  0.000,  1.514
   No. of observations.............. 128
==================================================================================
                                ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

==================================================================================
                       RESULTS FROM VISUAL CURVE MATCHING


VISUAL MATCH PARAMETER ESTIMATES

           Estimate
   K  =   1.2729E-004 ft/min
   y0 =   5.7028E-001 ft


<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
```
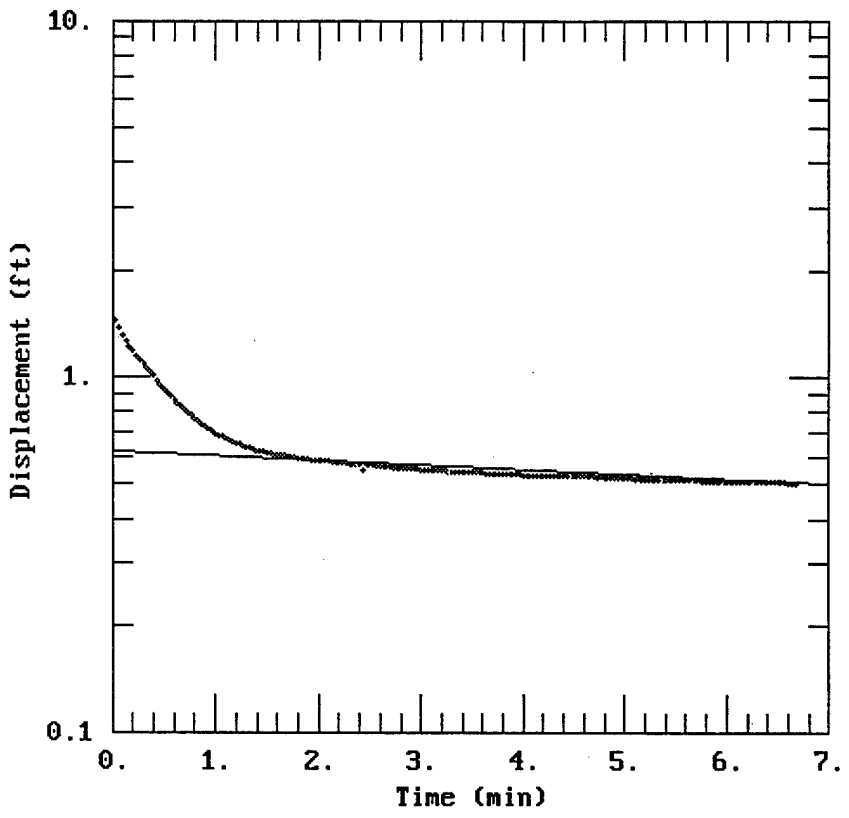

CLIENT: AFCEE	COMPANY: PARSONS ENGINEERING SCIENCE
LOCATION: KELLY AFB	PROJECT: 731854

RISING HEAD TEST #2 - KY024MW007



DATA SET:
RH2KY007.DAT
01/26/98

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 1.441 ft
r_c= 0.0833 ft
r_w= 0.3333 ft
L = 5.15 ft
b = 5.15 ft
H = 5.15 ft

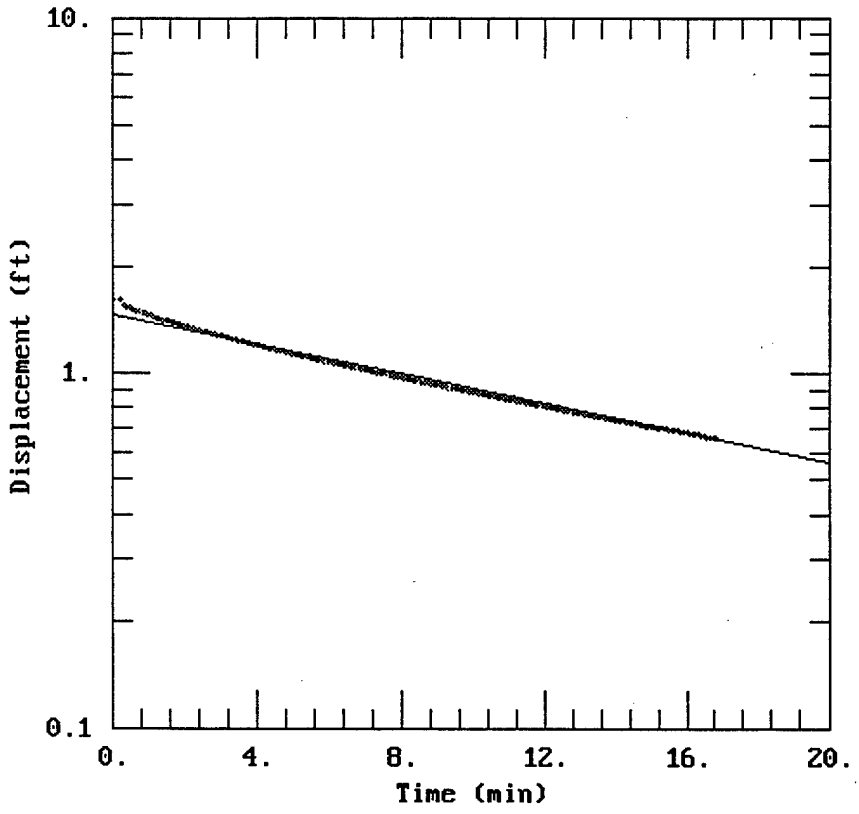
PARAMETER ESTIMATES:
K = 0.0002209 ft/min
y0 = 0.6169 ft

AQTESOLV

```
<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>

                        A Q T E S O L V    R E S U L T S
                                  Version 2.0

                       Developed by Glenn M. Duffield
                 (c) 1993, 1994 Geraghty & Miller, Inc.

01/26/98                                                               13:13:41
================================================================================
                                TEST DESCRIPTION

Data set........... RH2KY007.DAT
Output file........ RH2KY007.OUT
Data set title..... RISING HEAD TEST #2 - KY024MW007
Company............ PARSONS ENGINEERING SCIENCE
Project............ 731854
Client............. AFCEE
Location........... KELLY AFB
Test date.......... 11-17-97
Test well.......... KY024MW007

Units of Measurement
   Length.......... ft
   Time............ min

Test Well Data
   Initial displacement in well..... 1.441
   Radius of well casing............ 0.0833
   Radius of wellbore............... 0.3333
   Aquifer saturated thickness...... 5.15
   Well screen length............... 5.15
   Static height of water in well... 5.15
   Gravel pack porosity............. 0.3
   Effective well casing radius..... 0.1954
   Effective wellbore radius........ 0.3333
   Log(Re/Rw)....................... 2.001
   Constants A, B and C............. 0.000 ,   0.000,   1.514
   No. of observations.............. 200
================================================================================
                               ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

================================================================================
                       RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

          Estimate
   K  =   2.2089E-004 ft/min
   y0 =   6.1693E-001 ft

<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
```

CLIENT: AFCEE	COMPANY: PARSONS ENGINEERING SCIENCE
LOCATION: KELLY AFB	PROJECT: 731845

RISING HEAD TEST - SS043MW014



DATA SET:
RH1KY014.DAT
01/26/98

AQUIFER MODEL:
Unconfined
SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 1.612 ft
r_c= 0.0833 ft
r_w= 0.3333 ft
L = 20. ft
b = 33.24 ft
H = 33.24 ft

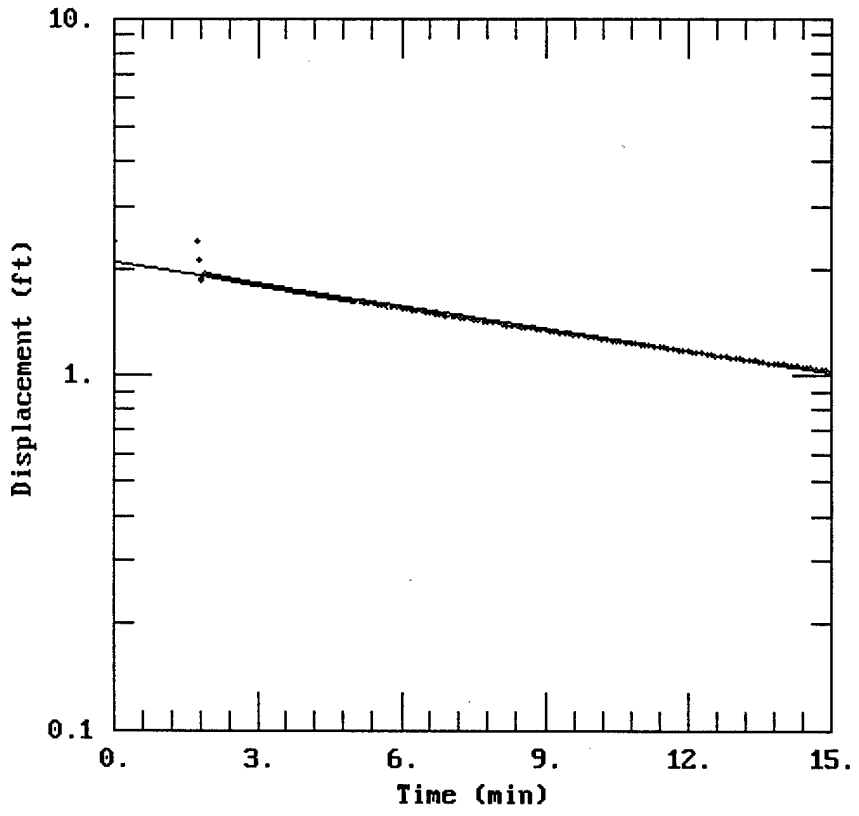
PARAMETER ESTIMATES:
K = 0.0001581 ft/min
y0 = 1.468 ft

AQTESOLV

```
<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>

                    A Q T E S O L V   R E S U L T S
                             Version 2.0

                    Developed by Glenn M. Duffield
                (c) 1993, 1994 Geraghty & Miller, Inc.

01/26/98                                                            13:58:59
================================================================================
                            TEST DESCRIPTION

Data set........... RH1KY014.DAT
Output file........ RH1KY014.OUT
Data set title..... RISING HEAD TEST - SS043MW014
Company............ PARSONS ENGINEERING SCIENCE
Project............ 731845
Client............. AFCEE
Location........... KELLY AFB
Test date.......... 11-14-97
Test well.......... SS043MW014

Units of Measurement
   Length.......... ft
   Time............ min

Test Well Data
   Initial displacement in well..... 1.612
   Radius of well casing............ 0.0833
   Radius of wellbore............... 0.3333
   Aquifer saturated thickness...... 33.24
   Well screen length............... 20
   Static height of water in well... 33.24
   Gravel pack porosity............. 0.3
   Effective well casing radius..... 0.1954
   Effective wellbore radius........ 0.3333
   Log(Re/Rw)....................... 3.462
   Constants A, B and C............. 0.000 ,  0.000,   2.990
   No. of observations.............. 200

================================================================================
                            ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

================================================================================
                   RESULTS FROM VISUAL CURVE MATCHING


VISUAL MATCH PARAMETER ESTIMATES

           Estimate
   K  =   1.5812E-004 ft/min
   y0 =   1.4676E+000 ft


<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
```

CLIENT: AFCEE	COMPANY: Parsons Engineering Science
LOCATION: Kelly AFB - Building 2093	PROJECT: 731854

Falling Head (Modified) - SS043MW014



DATA SET:
KY014MOD.DAT
01/26/98

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 2.377 ft
r_c= 0.0833 ft
r_w= 0.3333 ft
L = 20. ft
b = 33.24 ft
H = 33.24 ft

PARAMETER ESTIMATES:
K = 0.0001595 ft/min
y0 = 2.079 ft

AQTESOLV

<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>

A Q T E S O L V   R E S U L T S
Version 2.0

Developed by Glenn M. Duffield

11/26/98 13:47:42

==

TEST DESCRIPTION

Data set........... KY014MOD.DAT
Output file........ KY014MOD.OUT
Data set title..... Falling Head (Modified) - SS043MW014
Company............ Parsons Engineering Science
Project............ 731854
Client............. AFCEE
Location........... Kelly AFB - Building 2093
Test date.......... 11/17/97
Test well.......... SS043MW014

Units of Measurement
   Length.......... ft
   Time............ min

Test Well Data
   Initial displacement in well..... 2.377
   Radius of well casing............ 0.0833
   Radius of wellbore............... 0.3333
   Aquifer saturated thickness...... 33.24
   Well screen length............... 20
   Static height of water in well... 33.24
   Gravel pack porosity............. 0.3
   Effective well casing radius..... 0.1954
   Effective wellbore radius........ 0.3333
   Log(Re/Rw)....................... 3.462
   Constants A, B and C............. 0.000 , 0.000, 2.990
   No. of observations.............. 199

==

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

==

RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

	Estimate
K =	1.5952E-004 ft/min
y0 =	2.0788E+000 ft

<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>

EXHIBIT E

BENZENE IN GROUNDWATER (11/97)

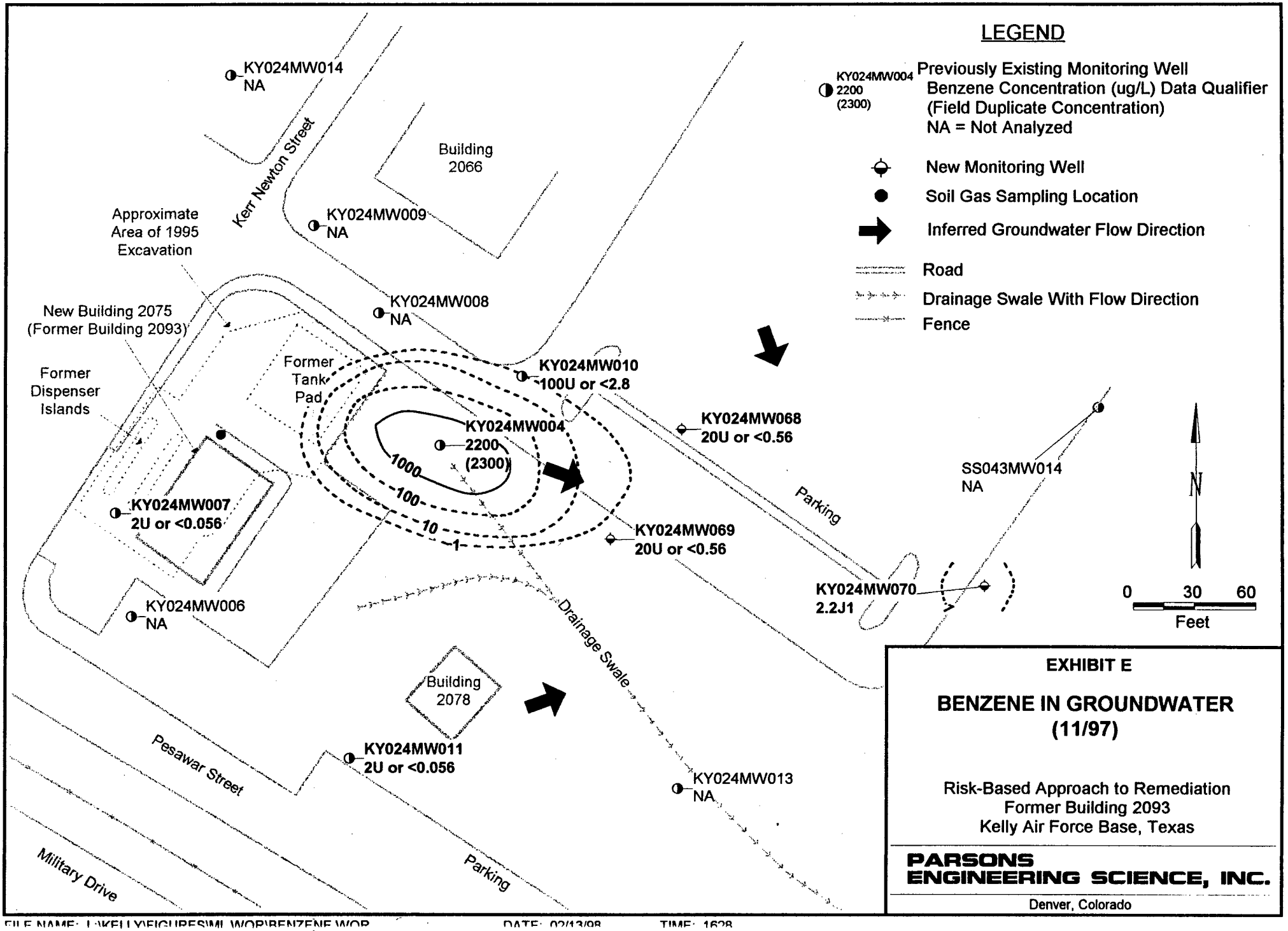


EXHIBIT E

BENZENE IN GROUNDWATER (11/97)

Risk-Based Approach to Remediation
Former Building 2093
Kelly Air Force Base, Texas

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

FILE NAME: I:\KELLY\FIGURES\MI_WOP\BENZENE.WOR DATE: 02/13/98 TIME: 1628

EXHIBIT F

BTEX IN GROUNDWATER (11/97)

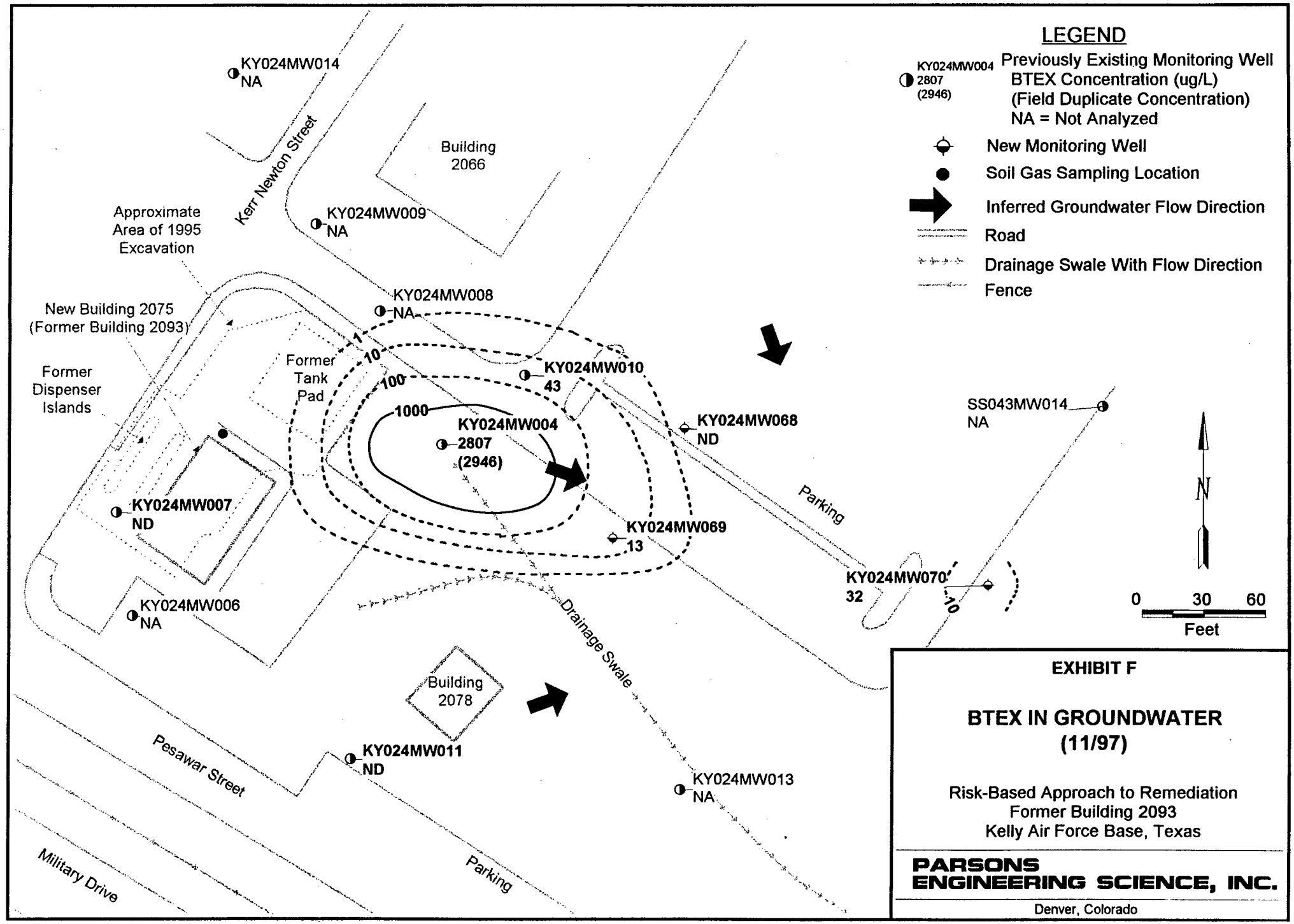


EXHIBIT F

BTEX IN GROUNDWATER (11/97)

Risk-Based Approach to Remediation
Former Building 2093
Kelly Air Force Base, Texas

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

FILE NAME: L:\KELLY\FIGURES\MI_WOR\BTEX.WOR DATE: 02/12/98 TIME: 1637

EXHIBIT G

MTBE IN GROUNDWATER (11/97)

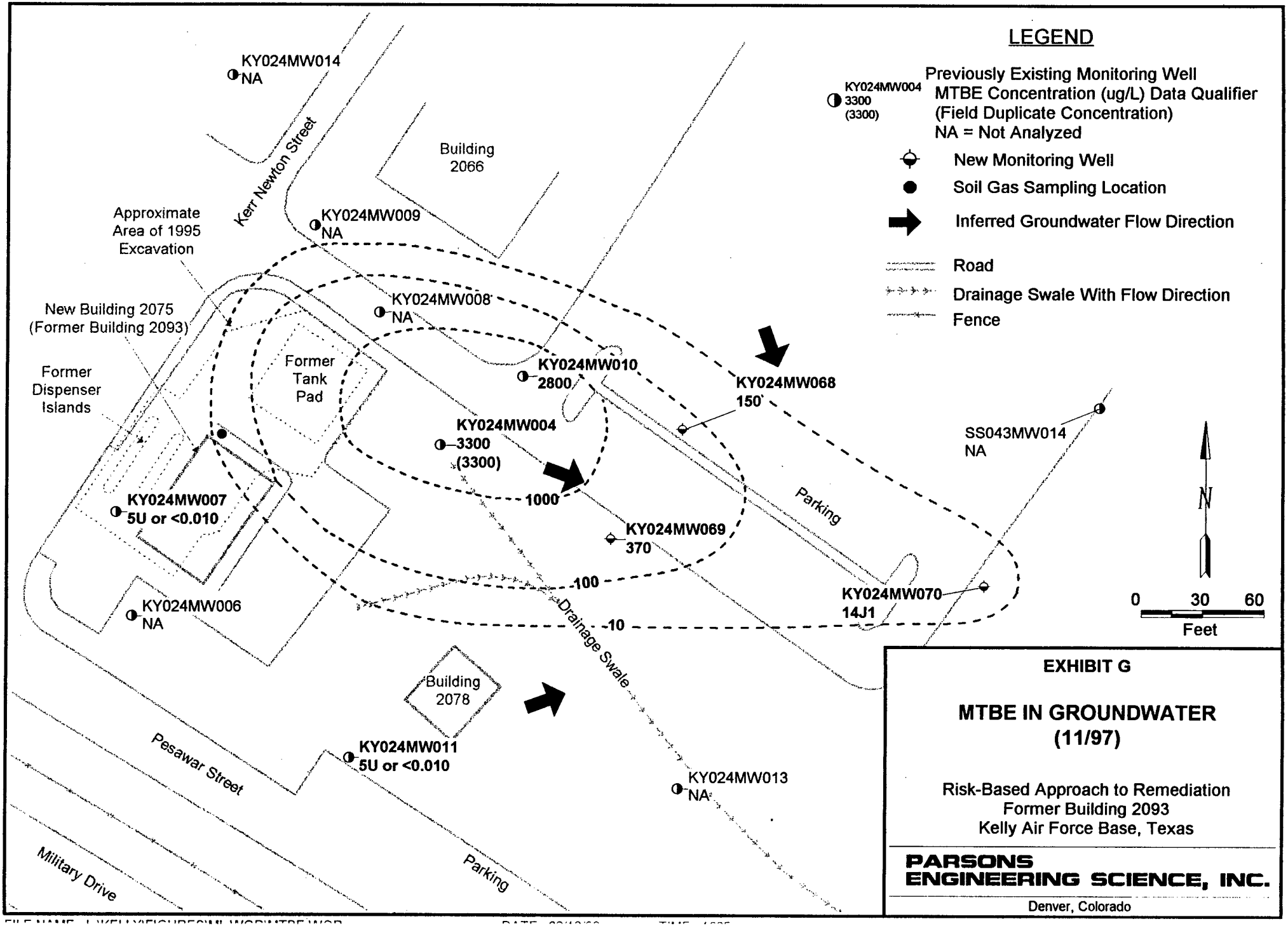


EXHIBIT G

MTBE IN GROUNDWATER (11/97)

Risk-Based Approach to Remediation
Former Building 2093
Kelly Air Force Base, Texas

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

EXHIBIT H

TOTAL LEAD IN GROUNDWATER (11/97)

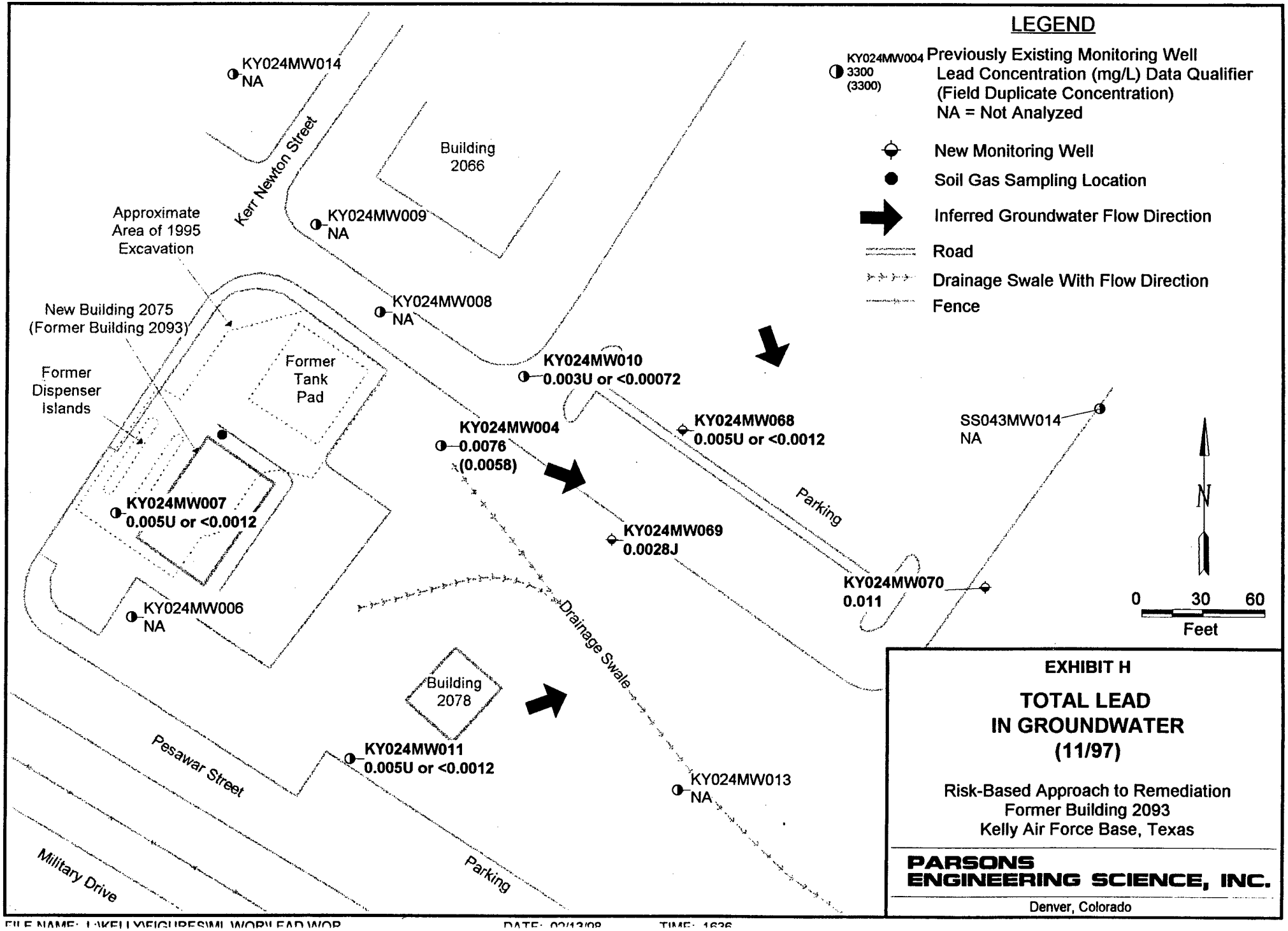


EXHIBIT H

TOTAL LEAD IN GROUNDWATER (11/97)

Risk-Based Approach to Remediation
Former Building 2093
Kelly Air Force Base, Texas

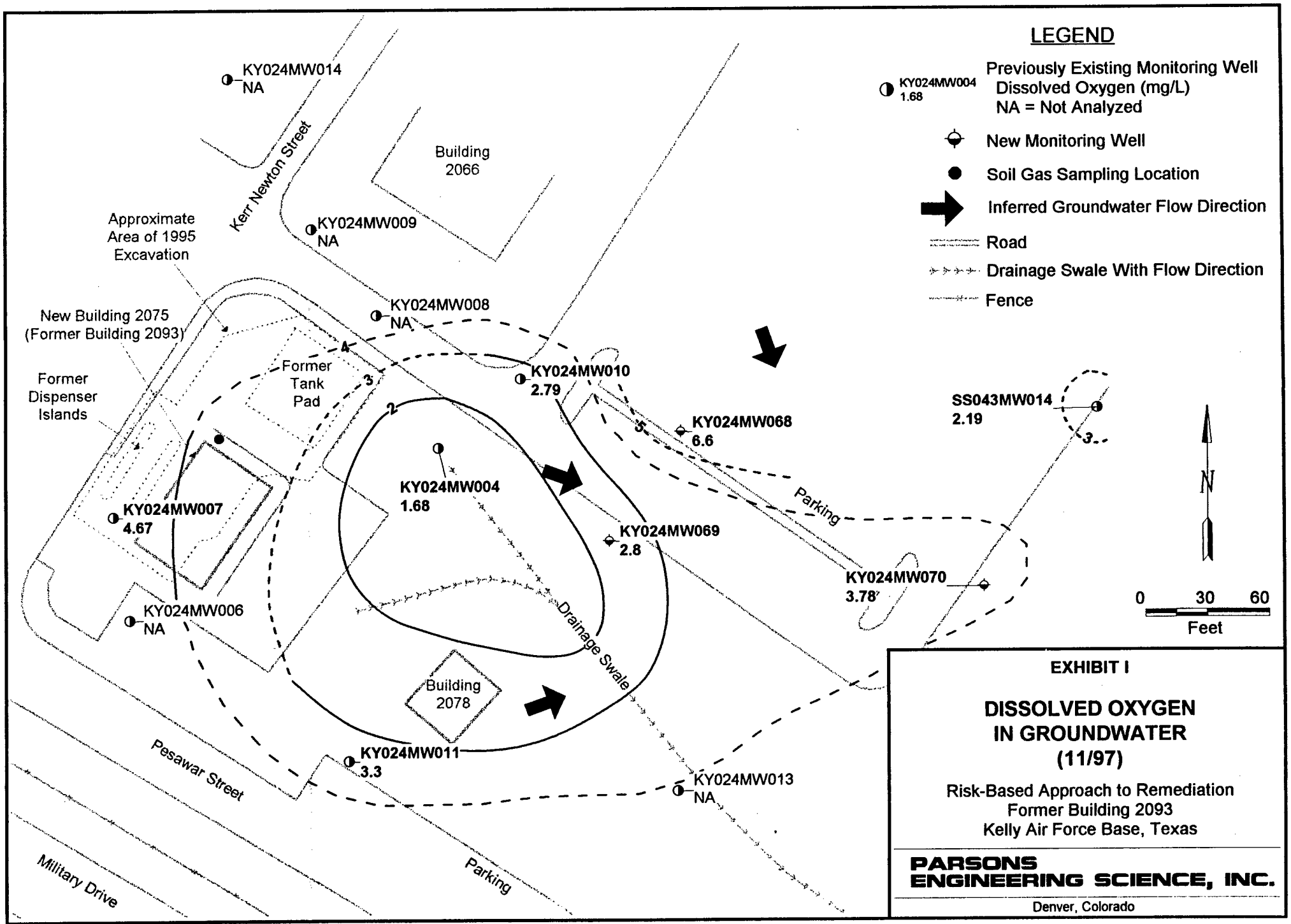
PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

FILE NAME: L:\KELLY\FIGURES\ML WOR\LEAD.WOR DATE: 02/13/98 TIME: 1636

EXHIBIT I

DISSOLVED OXYGEN IN GROUNDWATER (11/97)



FILE NAME: I:\KELLY\FIGURES\MI_WOR\DO.WOR DATE: 02/11/98 TIME: 1505

EXHIBIT J

REDUCTION/OXIDATION POTENTIAL IN GROUNDWATER (11/97)

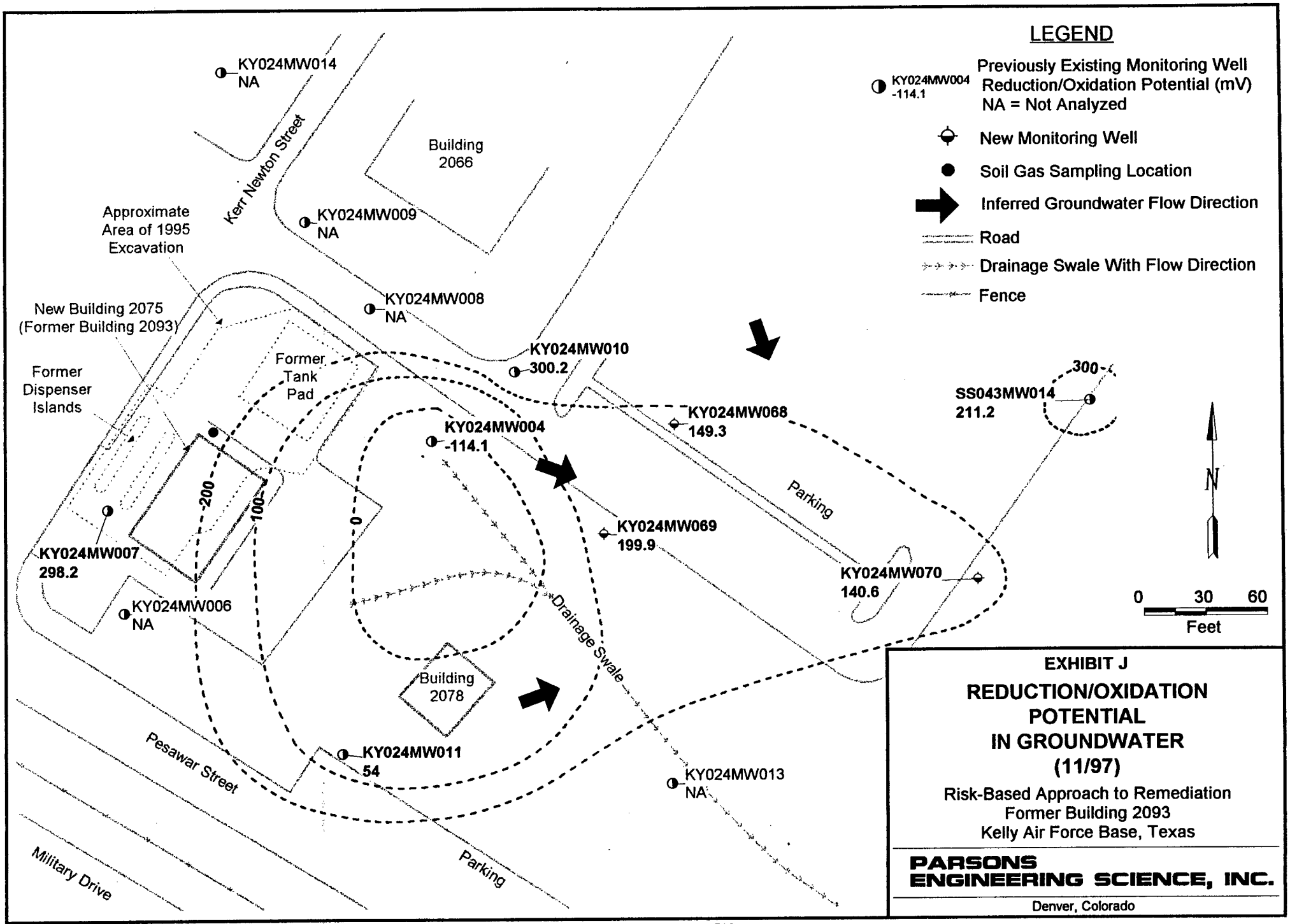


EXHIBIT J

REDUCTION/OXIDATION POTENTIAL IN GROUNDWATER (11/97)

Risk-Based Approach to Remediation
Former Building 2093
Kelly Air Force Base, Texas

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

FILE NAME: L:\KELLY\FIGURES\MI_WOR\REDOX.WOR DATE: 02/11/98 TIME: 1510

EXHIBIT K

NITRATE PLUS NITRITE AS NITROGEN IN GROUNDWATER (11/97)

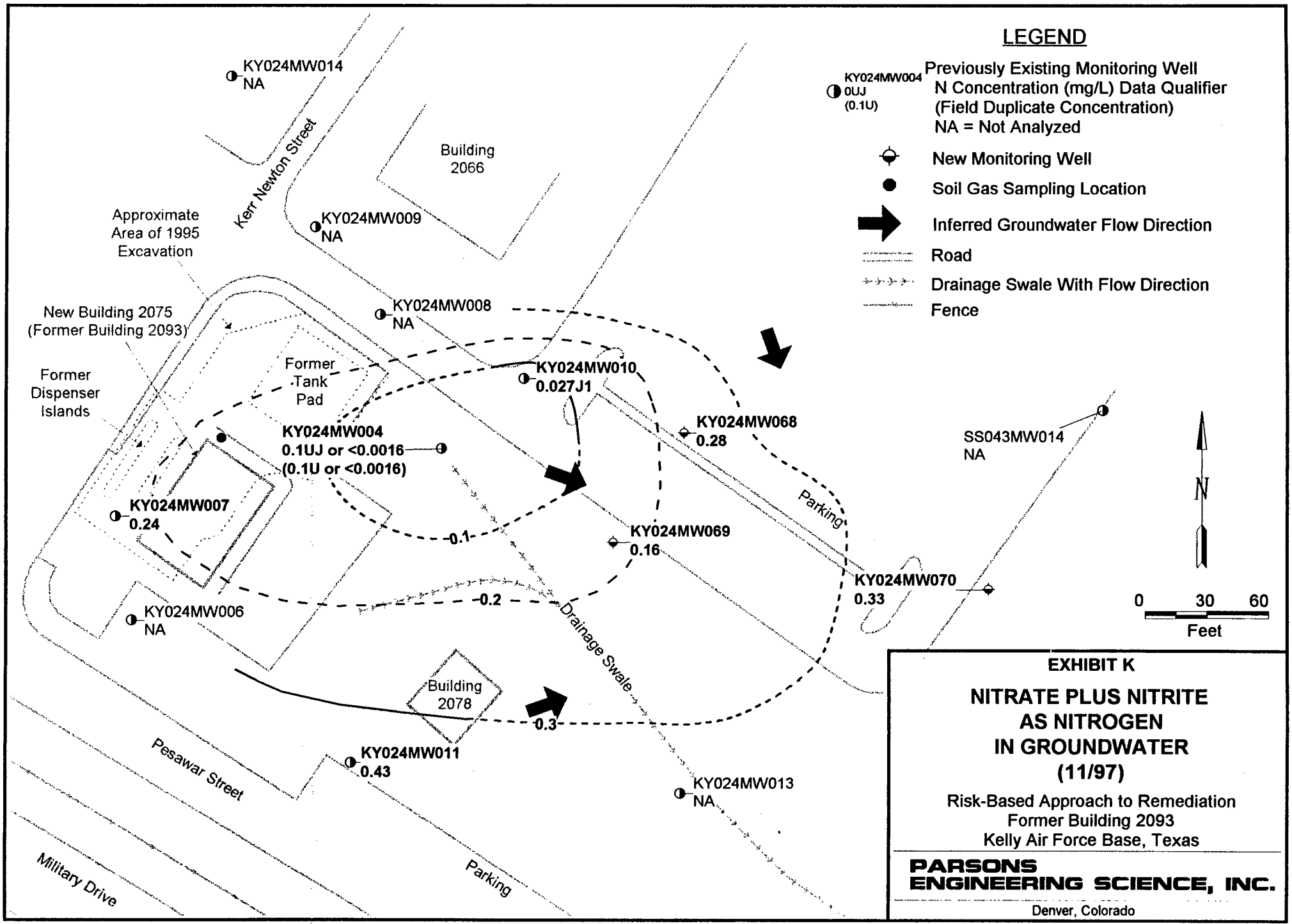


EXHIBIT K

NITRATE PLUS NITRITE AS NITROGEN IN GROUNDWATER (11/97)

Risk-Based Approach to Remediation
Former Building 2093
Kelly Air Force Base, Texas

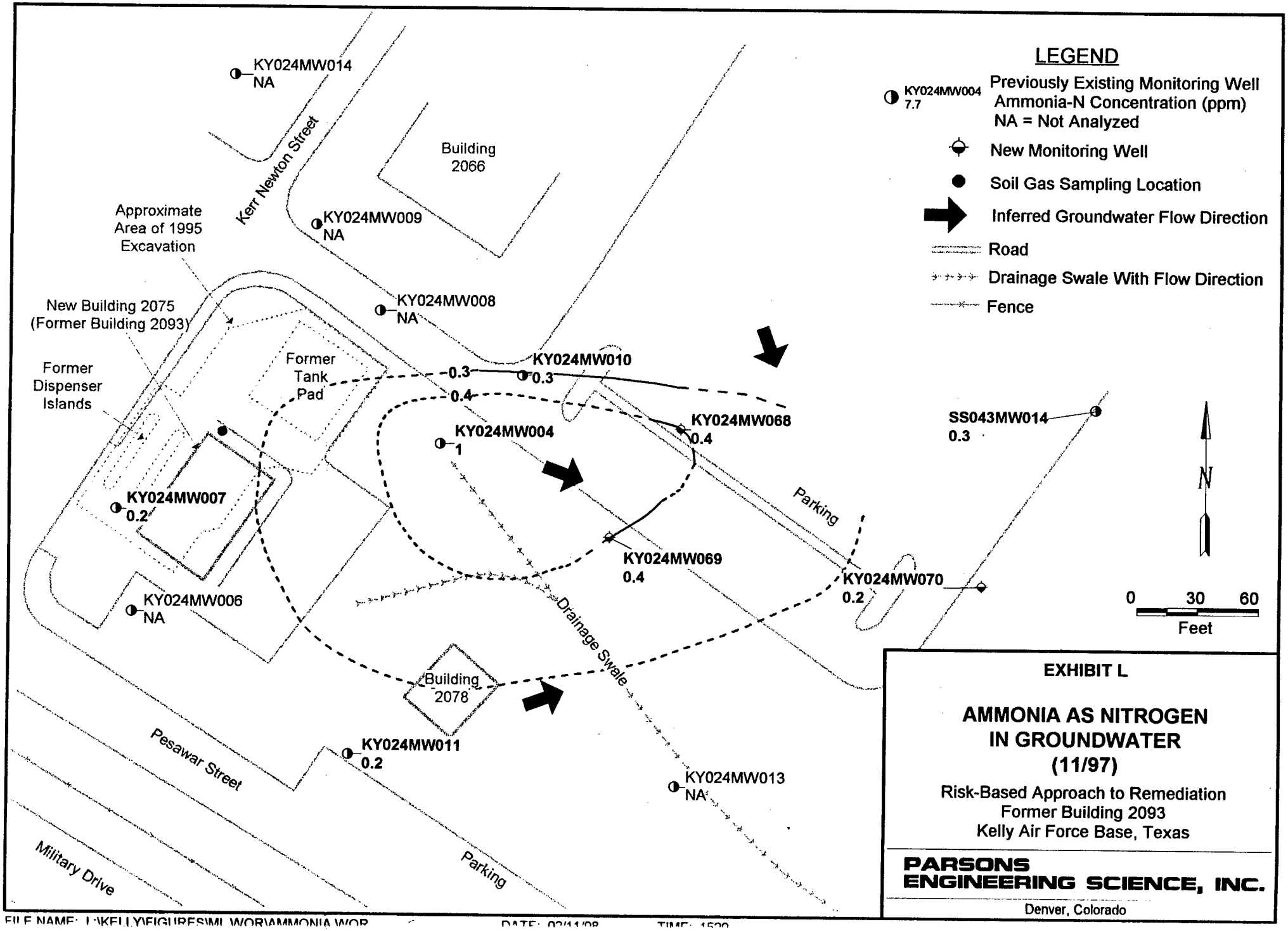
PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

FILE NAME: I:\KELLY\FIGURES\MI_WOR\NITRATE.WOR DATE: 02/13/98 TIME: 1637

EXHIBIT L

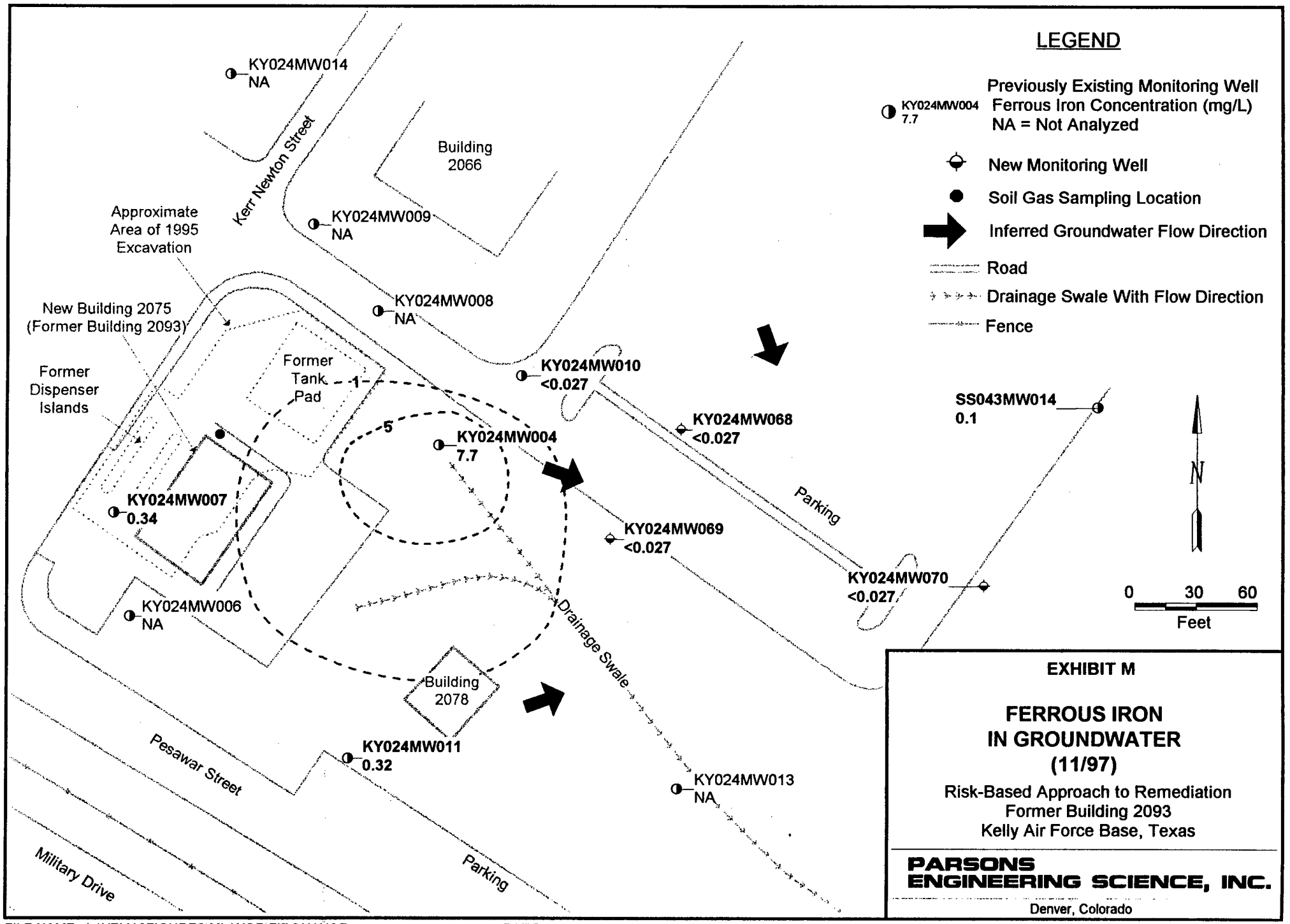
AMMONIA AS NITROGEN IN GROUNDWATER (11/97)



FILE NAME: L:\KELLY\FIGURES\ML WOR\AMMONIA.WOR DATE: 02/11/98 TIME: 1529

EXHIBIT M

FERROUS IRON IN GROUNDWATER (11/97)



FILE NAME: L:\KELLY\FIGURES\MI_WOR\FIRON.WOR DATE: 02/11/98 TIME: 1551

EXHIBIT N

SULFATE IN GROUNDWATER (11/97)

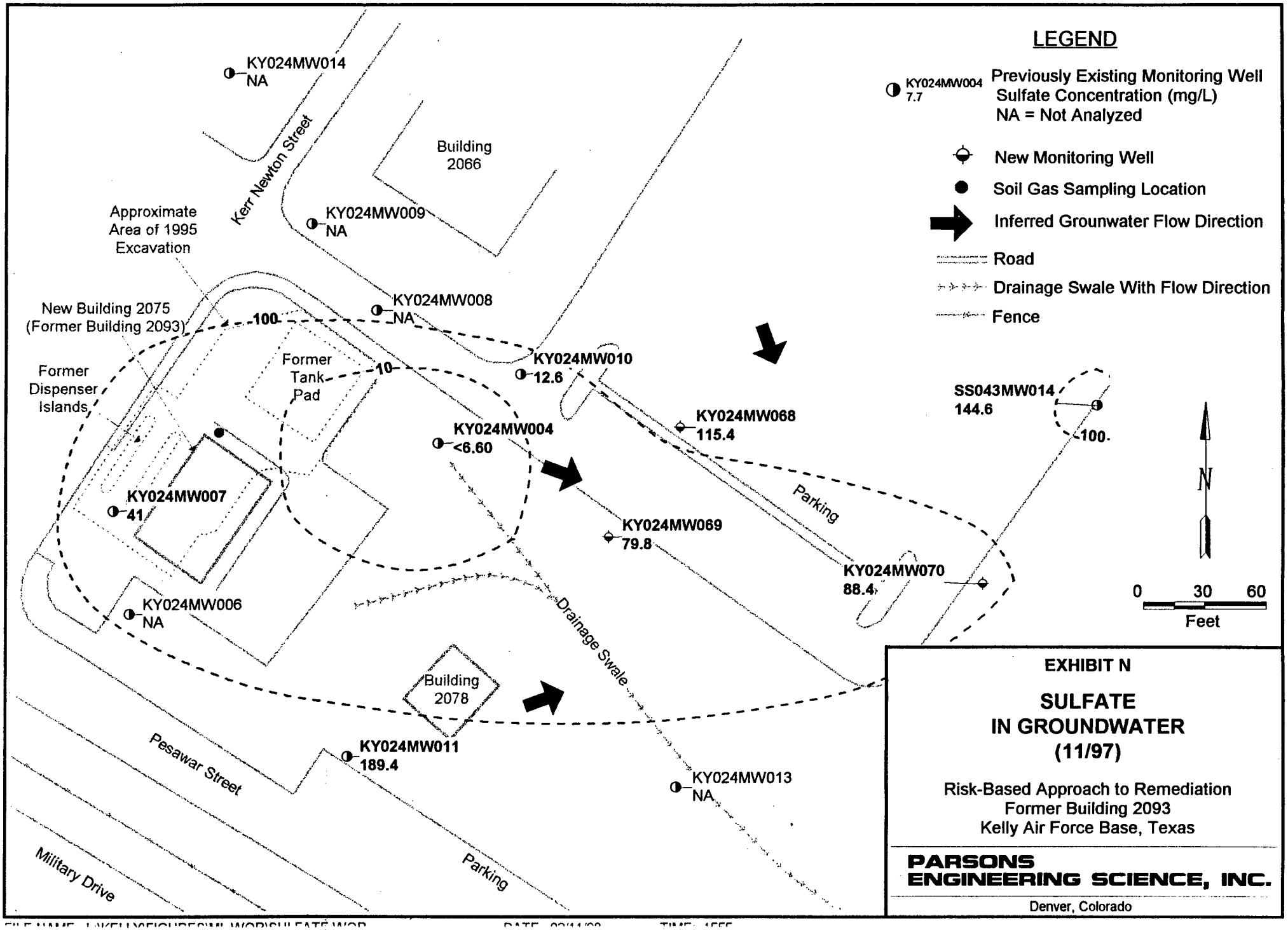
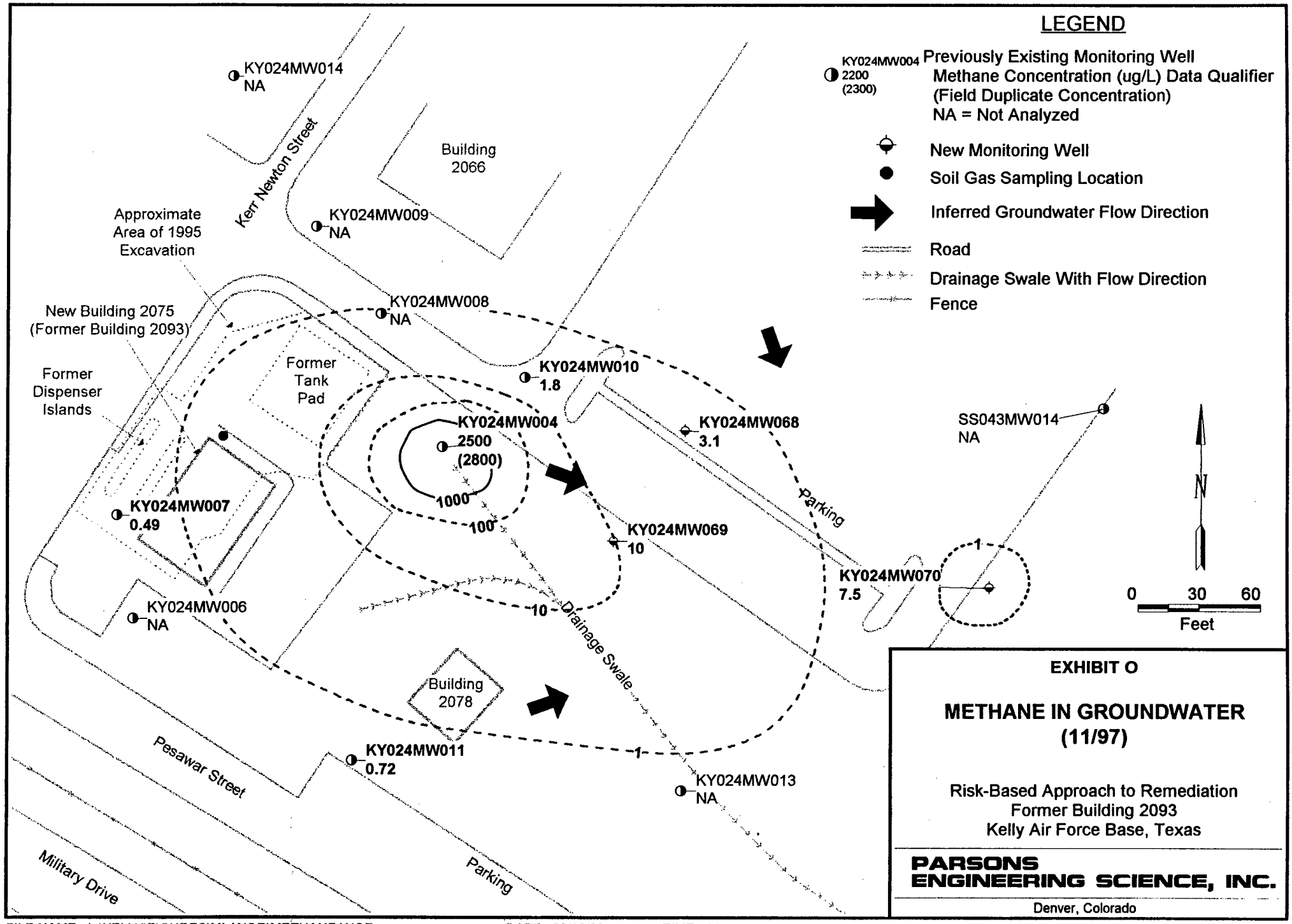

LEGEND
KY024MW004 7.7 Previously Existing Monitoring Well Sulfate Concentration (mg/L) NA = Not Analyzed
New Monitoring Well
Soil Gas Sampling Location
Inferred Grounwater Flow Direction
Road
Drainage Swale With Flow Direction
Fence
KY024MW014 NA
Kerr Newton Street
Building 2066
KY024MW009 NA
Approximate Area of 1995 Excavation
New Building 2075 (Former Building 2093)
100
KY024MW008 NA
Former Tank Pad
10
KY024MW010 12.6
Former Dispenser Islands
KY024MW004 <6.60
KY024MW068 115.4
SS043MW014 144.6
100
KY024MW007 41
KY024MW069 79.8
Parking
KY024MW070 88.4
N
0 30 60
Feet
KY024MW006 NA
Drainage Swale
Building 2078
Pesawar Street
KY024MW011 189.4
KY024MW013 NA
Military Drive
Parking
EXHIBIT N
SULFATE IN GROUNDWATER (11/97)
Risk-Based Approach to Remediation
Former Building 2093
Kelly Air Force Base, Texas
PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

EXHIBIT O

METHANE IN GROUNDWATER (11/97)



FILE NAME: L:\KELLY\FIGURES\MI WOR\METHANE WOR- DATE: 02/13/98 TIME: 1639

EXHIBIT P

EXPRESSED ASSIMILATIVE CAPACITY

EXHIBIT P

Expressed Assimilative Capacity

Mass-balance relationships can be used to determine how much contaminant mass can be degraded by each of the redox reactions that microorganisms might use to make free energy available for cell maintenance and production. The stoichiometric relationship between the contaminant and the electron acceptor can be used to estimate the expressed assimilative capacity of the groundwater. Once the redox reactions operating at these sites were defined, it is possible to estimate theoretically how much contaminant mass can be assimilated or oxidized by available electron acceptors. This analysis provides a basis for determining the potential for continued contaminant mass reduction in saturated media at the site.

A closed system with 2 liters of water can be used to help visualize the physical meaning of assimilative capacity. Assume that the first liter contains no fuel hydrocarbons, but it contains fuel degrading microorganisms and has an assimilative capacity (i.e., electron acceptors) of exactly "x" µg of fuel hydrocarbons based on stoichiometry. The second liter has no assimilative capacity; however, it contains fuel hydrocarbons. As long as these 2 liters of water are kept separate, biodegradation of the fuel hydrocarbons will not occur. If these 2 liters are combined in a closed system, biodegradation will commence and continue until the fuel hydrocarbons are depleted, the electron acceptors are depleted, or the environment becomes acutely toxic to the fuel degrading microorganisms. Assuming a nonlethal environment, if fewer than "x" µg of fuel hydrocarbons were in the second liter, all of the fuel hydrocarbons would eventually degrade given a sufficient time; likewise, if greater than "x" µg of fuel hydrocarbons were in the second liter of water, only "x" µg of fuel hydrocarbons would ultimately degrade.

The November 1997 groundwater samples were analyzed for a number geochemical parameter. Site groundwater data for DO suggest that natural attenuation of hydrocarbons in the shallow aquifer is occurring by aerobic biodegradation. In addition, data for nitrate/nitrite, ferrous iron, sulfate, and methane suggest that anaerobic degradation via denitrification, iron reduction, sulfate reduction, and methanogenesis is occurring. The occurrence of the process is evidenced by the depletion of electron acceptors (oxygen, nitrate, and sulfate) in the plume area and the production of metabolic byproducts of biodegradation reactions (ferrous iron and methane) Geochemical parameters for site groundwater are discussed in the following sections. On the basis of the stoichiometry of the various biodegradation reactions and observed differences between background and plume electron acceptor concentrations, the expressed assimilative capacity of groundwater at Former Building 2093 is at least 12,270 µg/L for BTEX or 12,490 µg/L for benzene alone (Table P.1).

TABLE P.1
EXPRESSED ASSIMILATIVE CAPACITY OF SITE GROUNDWATER
FORMER BUILDING 2093
KELLY AFB, TEXAS

Electron Acceptor or Process	Expressed BTEX Assimilative Capacity (µg/L)	Expressed Benzene Assimilative Capacity (µg/L)
Aerobic Respiration	950	970
Denitrification	130	130
Iron Reduction	340	340
Sulfate Reduction	7,450	7,610
Methanogenesis	3,400	3,440
Expressed Assimilative Capacity	12,270	12,490
Maximum BTEX Concentration (11/97)	2,800	-
Maximum Benzene Concentration (11/97)	-	2,200

The groundwater beneath Former Building 2093 is an open system, which continually receives additional electron receptors from upgradient and from the percolation of precipitation. This means that the assimilative capacity is not fixed as it is in a closed system, and therefore cannot be compared directly to contaminant concentrations in the groundwater. Rather, the expressed assimilative capacity of groundwater is intended to serve as a qualitative tool. The expressed assimilative capacity at this site is greater than the highest total BTEX concentration measured in November 1997 (2,800 µg/L) and the highest benzene concentration measured in November 1997 (2,200 µg/L). The fate of BTEX in groundwater and the potential impact on receptors is dependent on the relationship between the kinetics of biodegradation and the solute transport velocity (Chappelle, 1994). Due to the low hydraulic conductivity of the clayey soils underlying the site and the resulting low solute transport velocity (estimated to be approximately 21 feet per year), there should be ample time for the fuel hydrocarbons dissolved in groundwater to substantially biodegrade prior to impacting any potential receptors. Additionally, the expressed assimilative capacity is greater than the highest measured total BTEX concentration measured since 1995 (5,788 µg/L). This significant expressed assimilative capacity is a strong indicator that biodegradation is occurring and is sufficient to limit migration of the contaminant plume.

EXHIBIT Q

BIOSCREEN® MODEL

EXHIBIT Q

BIOSCREEN® MODEL

Q.1 MODEL DESCRIPTION

Bioscreen® is a screening model which simulates remediation by natural attenuation of dissolved hydrocarbons at petroleum fuel release sites (Newell *et al*, 1996). The software is based on the Domenico (1987) analytical solute transport model and is designed to simulate advection, dispersion, adsorption, and aerobic decay as well as anaerobic reactions that have been shown to be the dominant biodegradation processes at many petroleum release sites. Bioscreen® includes three different model types:

1) Solute transport without decay;

2) Solute transport with biodegradation modeled as a first-order decay process (simple, lumped parameter approach); and

3) Solute transport with biodegradation modeled as an "instantaneous" biodegradation reaction.

The first model is appropriate for predicting the movement of conservative (non-degrading) solutes such as chloride. The only attenuation mechanisms simulated are dispersion in the longitudinal, transverse, and vertical directions and adsorption of the contaminant to the soil matrix.

With the second model, the solute degradation rate is proportional to the solute concentration. This is a conventional method for simulating biodegradation in dissolved hydrocarbon plumes. With this method, dispersion, sorption, and biodegradation parameters are lumped together in a single calibration parameter. The

first-order decay model does not account for site-specific information such as the availability of electron acceptors. In addition, it does not assume any biodegradation of dissolved constituents in the source zone. In other words, this model assumes biodegradation starts immediately downgradient of the source.

First-order expressions may not be accurate for describing natural attenuation processes. Biodegradation of organic contaminants in groundwater is more difficult to quantify using a first-order decay equation because electron acceptor limitations are not considered. A more accurate prediction of biodegradation effects may be realized by incorporating the instantaneous reaction equation into a transport model. This is because the instantaneous reaction model uses site-specific data, including representative concentrations of electron acceptors such as dissolved oxygen, nitrate, and sulfate and biodegradation by-products such as ferrous iron and methane.

At almost all petroleum release sites, biodegradation is present and can be verified by demonstrating the consumption of aerobic and anaerobic electron acceptors. Therefore, results from the No Biodegradation model are intended only to be used for comparison purposes and to demonstrate the effects of biodegradation on plume migration. The Instantaneous Reaction model is recommended either alone or in addition to the First-Order Decay model for most sites where site-specific electron acceptor and biodegradation by-product data is available (Newell *et al*, 1996).

Q.2 MODELING OBJECTIVES

The Bioscreen® modeling was performed for the former Building 2093 site to accomplish the following two objectives:

- To estimate the maximum migration distance of the benzene plume from the source area over time; and
- To estimate how long the maximum benzene concentration in the plume will exceed its groundwater quality standard.

Because the site is dominated by methane production (see Exhibits O and P), it was assumed that benzene will degrade last and that the dissolved material at the edge of the plume is primarily benzene (Newell *et al*, 1996). In addition, benzene is the only BTEX compound that is present in groundwater at concentrations above the TNRCC Plan A target groundwater concentration of 29.4 µg/L. Therefore, benzene was the contaminant modeled.

Q.3 CONCEPTUAL MODEL DESIGN AND LIMITING ASSUMPTIONS

Bioscreen has the following limitations:

1. As an analytical model, Bioscreen® assumes simple, uniform groundwater flow conditions; and
2. As a screening tool, Bioscreen only approximates the more complicated processes that occur in the field.

Because the model is not capable of simulating a complicated flow regime, the hydraulic model input parameters were based on field data collected from the primary contaminant migration pathway at the site (i.e., in the vicinity of KY024MW004).

Q.4 INITIAL MODEL INPUT DATA

Input data for the Bioscreen® model are used to calculate groundwater velocity, aquifer dispersivity, a contaminant retardation coefficient, a contaminant decay coefficient, dissolved contaminant concentrations in the source area, a half-life of the contaminant source, and the dimensions of the source zone. Each of these input values is described in more detail below and summarized in Table Q.1.

Q.4.1 Groundwater Velocity

The advective groundwater velocity beneath the site is based on site specific hydraulic conductivity and hydraulic gradient data and an estimated effective porosity of 5 percent based on published values for clay and silty clay (Spitz and Moreno,

1996). The hydraulic conductivity value used in the model (1.5×10^{-4} cm/sec) is the highest value calculated from slug test data collected downgradient from the source area in November 1997. The high value used would tend to overestimate plume migration. The hydraulic gradient value used in the model (0.01 ft/ft) is derived from the groundwater elevation data collected in November 1997. The value of advective groundwater velocity calculated by Bioscreen® is 31 ft/yr.

Q.4.2 Dispersivity

Dispersion refers to the process whereby a plume will spread out in a longitudinal direction (along the direction of groundwater flow), transversely (perpendicular to groundwater flow), and vertically downward due to mechanical mixing and chemical diffusion in the aquifer. The longitudinal, transverse, and vertical dispersivities used in the model are calculated by Bioscreen® from a maximum estimated plume length of 300 feet.

Q.4.3 Retardation

Retardation of benzene relative to the advective velocity of the groundwater occurs when benzene molecules are sorbed to organic carbon, silt, or clay particles in the aquifer matrix. Increasing the retardation coefficient decreases the contaminant migration velocity relative to the advective groundwater velocity, causing the contaminant to be biodegraded to a greater degree along a given travel path. A retardation coefficient was estimated for the site based on accepted values from literature (Newell *et al*, 1996). Because TOC was not detected in site soils, an estimated fraction organic carbon value was used to calculate the retardation coefficient used in the Bioscreen model. Using a fraction organic carbon of 0.0002, an estimated soil bulk density of 1.7 kg/L, and a partition coefficient for benzene of 79 L/kg

(Wiedemeier *et al*, 1996), a retardation coefficient of 1.54 was calculated for benzene at the site.

Q.4.4 First-Order Decay Coefficient

Bioscreen® uses the first-order decay coefficient to simulate biodegradation of dissolved contaminants after they have migrated downgradient from the source area. The first-order decay coefficient equals the half-life of the contaminant divided by 0.693. The half-life of benzene published in literature typically ranges from 0.02 to 2 years (Newell *et al*, 1996). The method of Buschek and Alcantar (1995) was used to calculate a first-order decay rate from site-specific data. Using data from both November 1992 and November 1997, a decay rate of 0.002 day^{-1} (0.6 $year^{-1}$) was calculated for benzene at the site. This decay rate corresponds to a half-life of 0.95 years.

Q.4.5 Instantaneous Reaction Data

The instantaneous reaction model in Bioscreen uses field data for certain electron acceptors to calculate a biodegradation rate. The input data include the change in dissolved oxygen, nitrate, and sulfate concentrations between the source area of the plume and an upgradient, background area and the observed ferrous iron and methane concentrations in the source area of the plume. Assuming that the biodegradation of benzene has produced 25 percent of the reaction by-products (and the biodegradation of toluene, ethylbenzene, and xylenes the other 75 percent), the November 1997 geochemical concentration differences between upgradient and source areas, described above, were divided by four prior to use in the instantaneous reaction model.

Q.4.6 Source Area Dimensions and Concentrations

Bioscreen® assumes a source represented by a vertical plane perpendicular to groundwater flow. The cross-sectional area of the vertical plane was estimated from

the benzene data collected in November 1997. The maximum benzene concentration in the source area was conservatively estimated to be 5,000 µg/L. The thickness of the dissolved plume was estimated to be 20 feet based on previously collected soil and groundwater data.

Q.4.7 Source Half-Life

Bioscreen® incorporates an approximation for a declining source concentration over time. The declining source term assumes that the mass of contaminant in the source area dissolves slowly as fresh groundwater passes through, and that the change in source zone concentration can be approximated as a first-order decay process. The model will compute an estimated source half-life given the estimated mass of contaminant present in the source area. Since the contaminated soil was excavated early in 1995, it was assumed that little residual contamination remains to act as a source of continuing groundwater contamination. Assuming 2000 cubic feet of contaminated soil remains that has a concentration of 0.1 mg/kg of benzene, the dissolvable mass of benzene in the source area is approximately 0.01 kg.

Q.5 Model Results

The model was run for 5, 10, and 15 years from 1997 to determine the maximum plume extent and benzene concentrations. Results of the model run are shown on Attachment Q.2. The year 2002 graph of the concentration vs. distance from the source area for the instantaneous reaction model indicates that dissolved benzene will no longer be detected at the site. The first-order decay model results indicate that the maximum dissolved benzene concentration on site will be approximately 186 µg/L located 105 feet from the source area. The first-order decay graph for the year 2007 prediction indicates that the maximum dissolved benzene concentration at the site will be 14 µg/L located 210 feet downgradient from the source. First-order decay results

for the year 2012 indicate that benzene will no longer be detectable above Texas state standards.

Q.7 CONCLUSION

Results of the Bioscreen model indicate that the maximum migration distance of dissolved benzene from the source area will be approximately 300 feet. Results also indicate that site concentrations of benzene will be below groundwater quality standards before the year 2012.

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Kelly AFB
B2093
Run Name

Data Input Instructions:

115 ▷ *1. Enter value directly, ..or*
or
0.02 *2. Calculate by filling in grey cells below. (To restore formulas, hit button below)*

Variable* ▷ *Data used directly in model.*
20 ▷ *Value calculated by model. (Don't enter any data)*

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	31.0	*(ft/yr)*
or		*or*	
Hydraulic Conductivity	*K*	1.5E-04	*(cm/sec)*
Hydraulic Gradient	*i*	0.01	*(ft/ft)*
Porosity	*n*	0.05	*(-)*

2. DISPERSION

Longitudinal Dispersivity*	*alpha x*	15.0	*(ft)*
Transverse Dispersivity*	*alpha y*	1.5	*(ft)*
Vertical Dispersivity*	*alpha z*	0.0	*(ft)*
or		*or*	
Estimated Plume Length	*Lp*	350	*(ft)*

3. ADSORPTION

Retardation Factor*	*R*	1.5	*(-)*
or		*or*	
Soil Bulk Density	*rho*	1.7	*(kg/l)*
Partition Coefficient	*Koc*	78	*(L/kg)*
FractionOrganicCarbon	*foc*	2.0E-4	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	6.2E-1	*(per yr)*
or		*or*	
Solute Half-Life	*t-half*		*(year)*
or Instantaneous Reaction Model			
Delta Oxygen*	*DO*	0.75	*(mg/L)*
Delta Nitrate*	*NO3*	0.035	*(mg/L)*
Observed Ferrous Iron*	*Fe2+*	1.9	*(mg/L)*
Delta Sulfate*	*SO4*	8.6	*(mg/L)*
Observed Methane*	*CH4*	0.625	*(mg/L)*

5. GENERAL

Modeled Area Length*	350	*(ft)*	L
Modeled Area Width*	240	*(ft)*	W
Simulation Time*	5	*(yr)*	

6. SOURCE DATA

Source Thickness in Sat.Zone* 20 *(ft)*

Source Zones:

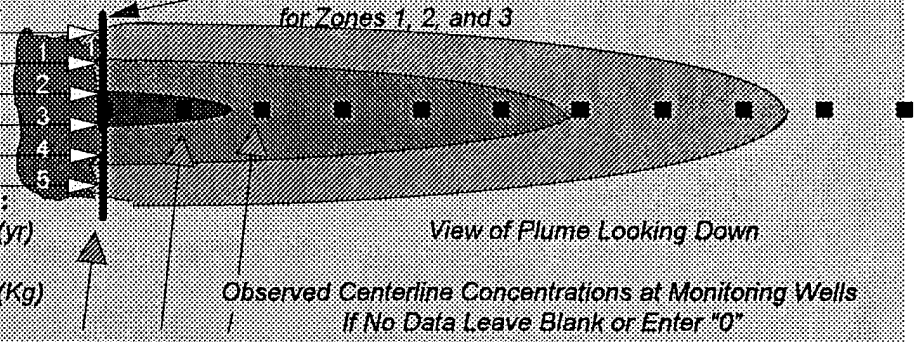
Width* (ft)	Conc. (mg/L)*
10	0.05
10	0.5
20	5
10	0.5
10	0.05

Source Halflife (see Help):

Inst. React.	1st Order	
<1	<1	*(yr)*

Soluble Mass in Source NAPL, Soil: 0.01 *(Kg)*

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	0	35	70	105	140	175	210	245	280	315	350
Concentration (mg/L)											

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

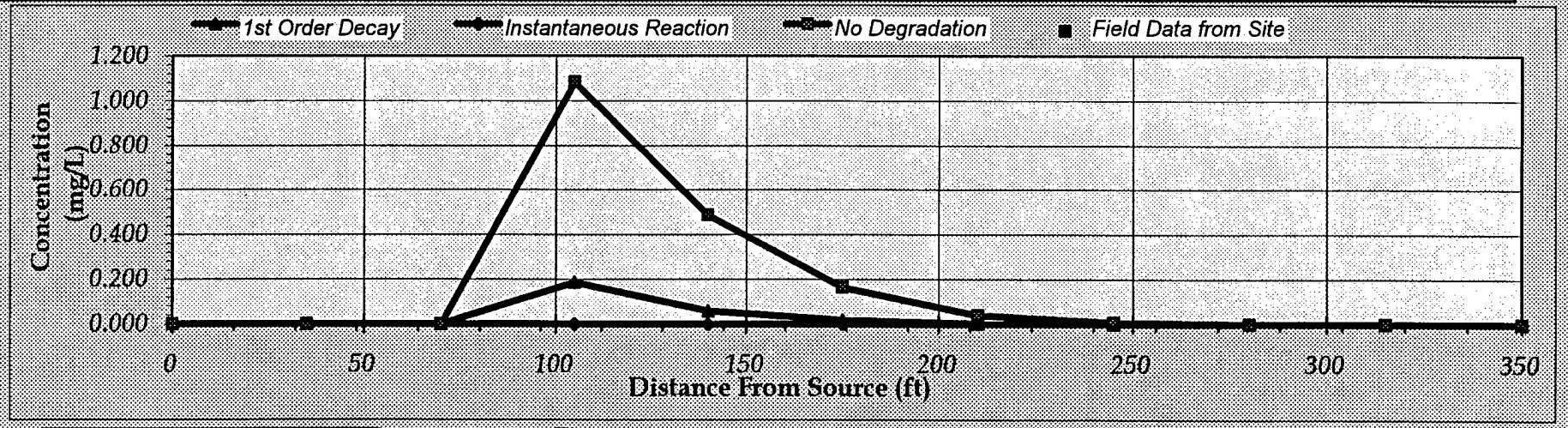
Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	35	70	105	140	175	210	245	280	315	350
No Degradation	0.000	0.000	0.000	1.082	0.485	0.164	0.040	0.007	0.001	0.000	0.000
1st Order Decay	0.000	0.000	0.000	0.186	0.060	0.016	0.003	0.001	0.000	0.000	0.000
Inst. Reaction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Next Timestep

Prev Timestep

Time:

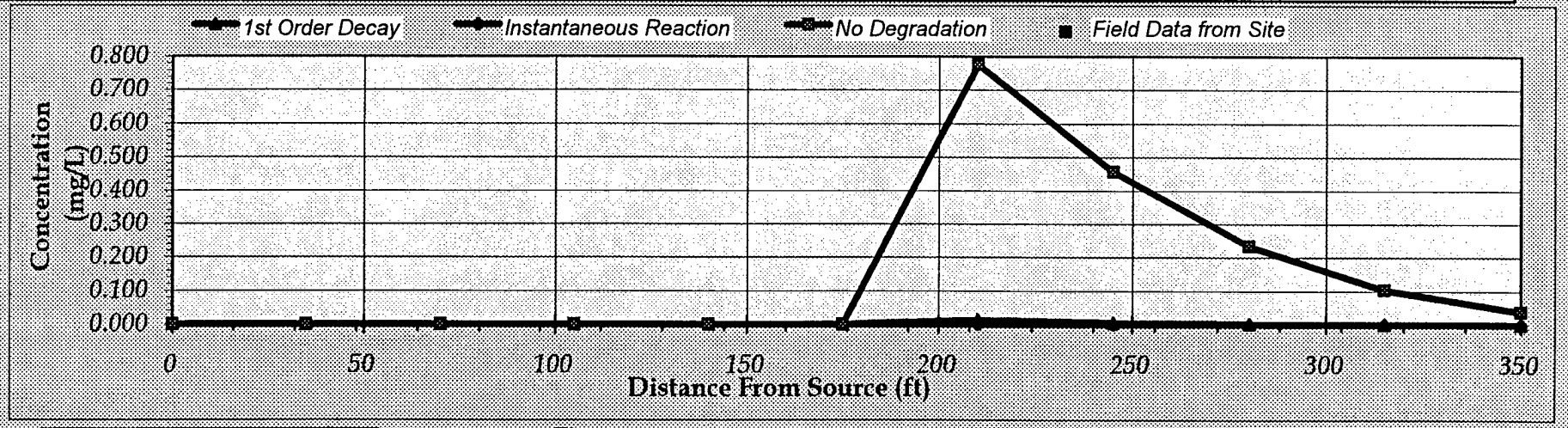
5 Years

Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

TYPE OF MODEL	Distance from Source (ft) 0	35	70	105	140	175	210	245	280	315	350
No Degradation	0.000	0.000	0.000	0.000	0.000	0.000	0.775	0.456	0.234	0.102	0.038
1st Order Decay	0.000	0.000	0.000	0.000	0.000	0.000	0.014	0.005	0.002	0.001	0.000
Inst. Reaction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Next Timestep

Prev Timestep

Time:

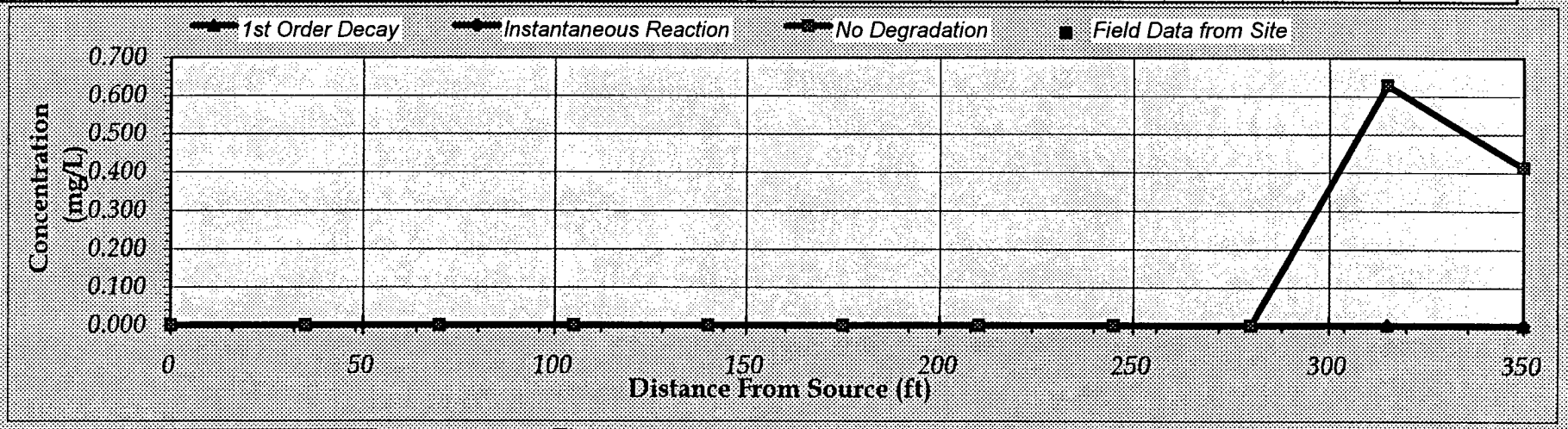
10 Years

Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

TYPE OF MODEL	Distance from Source (ft) 0	35	70	105	140	175	210	245	280	315	350
No Degradation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.629	0.413
1st Order Decay	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
Inst. Reaction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Next Timestep

Prev Timestep

Time:

15 Years

Return to Input

Recalculate This Sheet

EXHIBIT R

SOIL BORING LOGS AND MONITOR WELL CONSTRUCTION DIAGRAMS

PARSONS
PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado (303) 831-8100

LOG OF BORING KY024MW068

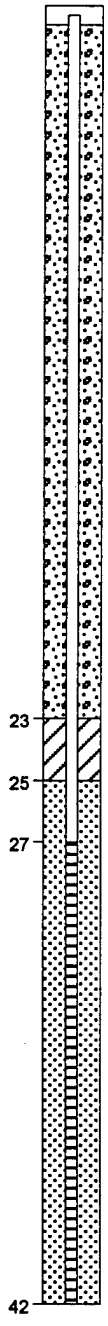
Kelly Air Force Base
San Antonio, Texas

JOB NUMBER	: 731854.07000	DRILLING AGENCY	: USACE
CLIENT	: KELLY AFB	INSPECTOR	: KEN McCLESKEY
DATE	: 11/16/1997	NORTHING	: 558,366.75
DRILLING METHOD	: HSA	EASTING	: 2,128,406.75

Depth in feet	GRAPHIC	USCS	DESCRIPTION	PID ppmv
0		GW	asphalt	0.0
			SAND & GRAVEL, medium dense, dry to moist	0.0
		GC	GRAVEL, medium dense, limestone and chert, dry to moist, up to 3" diameter, some cobbles, angular to subrounded, slightly clayey to very clayey, slightly sandy	
			SHALE, weathered, soft, dry to moist, yellow-brown to gray, blocky structure, slightly silty to silty, Fe-oxide staining, caliched to very caliched 5.5' to 25', highly weathered 5.5' to 10'	8.0
10				2.1
20				0.0
			thicker silty lenses 24'	3.1
				9.2
				2.5
30				5.9
				2.0
40				0.0

Total depth = 43 ft.

KY024MW068
ELEV: 724.28



Well Construction Information

Surface Elevation	: 724.60 ft. msl
TOC Elevation	: 724.28 ft. msl
Casing Material	: PVC
Casing Interval	: 0 - 27 ft. bgs.
Screen Material	: preslotted PVC
Screen Interval	: 27 - 42 ft. bgs.
Screen Slot Size	: 0.010 in.
Seal Material	: Bentonite
Seal Interval	: 23 - 25 ft. bgs.
Filter Pack	: 20/40 Silica Sand
Filter Pack Interval	: 25 - 43 ft. bgs.
Total Well Depth	: 42 ft. bgs.
Well Diameter	: 2 in.
Total Boring Depth	: 43 ft. bgs.
Borehole Diam.	: 8 in.

NOTES

Soil samples for PID screening and lithology identification were collected from the auger flights at two foot intervals during drilling.

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PARSONS
PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado (303) 831-8100

LOG OF BORING KY024MW069

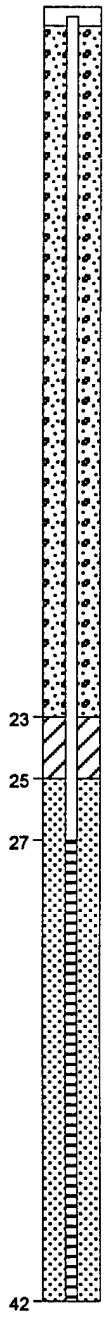
Kelly Air Force Base
San Antonio, Texas

JOB NUMBER	: 731854.07000	DRILLING AGENCY	: USACE
CLIENT	: KELLY AFB	INSPECTOR	: KEN McCLESKEY
DATE	: 11/17/1997	NORTHING	: 558,312.80
DRILLING METHOD	: HSA	EASTING	: 2,128,371.66

Depth in feet	GRAPHIC	USCS	DESCRIPTION	PID ppmv
0		CL	CLAY, low plasticity, soft to firm, dry to moist, dark brown, slightly sandy, silty, slightly gravelly	0.0
		SC	SAND, loose to medium dense, fine to medium grain, moist, red, slightly clayey	0.0
		GC	GRAVEL, medium dense, limestone and chert, dry to moist, some cobbles, angular to subrounded, clayey to very clayey, slightly sandy	0.0
10			SHALE, weathered, soft, dry to moist, yellow-brown to gray, blocky structure, slightly silty to silty, caliched to very caliched 5.3' to 15',	0.0
20			thicker silty lenses below 24.2'	
30				
40				0.0

Total depth = 43 ft.

KY024MW069
ELEV: 725.88



Well Construction Information

Surface Elevation	: 726.16 ft. msl.
TOC Elevation	: 725.88 ft. msl.
Casing Material	: PVC
Casing Interval	: 0 - 27 ft. bgs.
Screen Material	: preslotted PVC
Screen Interval	: 27 - 42 ft. bgs.
Screen Slot Size	: 0.010 in.
Seal Material	: Bentonite
Seal Interval	: 23 - 25 ft. bgs.
Filter Pack	: 20/40 Silica Sand
Filter Pack Interval	: 25 - 43 ft. bgs.
Total Well Depth	: 42 ft. bgs.
Well Diameter	: 2 in.
Total Boring Depth	: 43 ft. bgs.
Borehole Diam.	: 8 in.

NOTES

Soil samples for PID screening and lithology indentification were collected form the auger flights at two foot intervals during drilling.

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PARSONS
PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado (303) 831-8100

LOG OF BORING KY024MW070

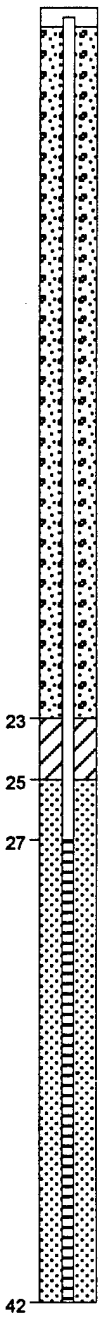
Kelly Air Force Base
San Antonio, Texas

JOB NUMBER	: 731854.07000	DRILLING AGENCY	: USACE
CLIENT	: KELLY AFB	INSPECTOR	: KEN McCLESKEY
DATE	: 11/14/1997	NORTHING	: 558,290.14
DRILLING METHOD	: HSA	EASTING	: 2,128,554.82

Depth in feet	GRAPHIC	USCS	DESCRIPTION	PID ppmv
0		CL	CLAY, medium plastic, firm, dry to moist, dark brown, slightly sandy, slightly silty, slightly gravelly, slightly caliched, Fe-oxide staining @ 4.5'	0.0
		GW	GRAVEL, loose to medium dense, limestone and chert, dry, angular to subangular, up to 3" diameter, slightly sandy, silty, clayey, some cobbles	0.0
10			SHALE, highly weathered, soft, dry to moist, yellow-brown to gray, slightly silty to silty, Fe-oxide staining, caliched to very caliched, dendrites, scattered silty lenses (Fe-oxide stained)	0.0
			vague blocky structure 9.2' to 16.5'	
			caliched to very caliched 9.2' to 19'	
			good blocky structure 16.5' to 43.0'	
20				
			thicker silty lenses 24' to 43'	
30				
40				0.0

Total depth = 43 ft.

KY024MW070
ELEV: 721.38



Well Construction Information

Surface Elevation	: 721.82 ft. msl.
TOC Elevation	: 721.38 ft. msl.
Casing Material	: PVC
Casing Interval	: 0 - 27 ft. bgs.
Screen Material	: preslotted PVC
Screen Interval	: 27 - 42 ft. bgs.
Screen Slot Size	: 0.010 in.
Seal Material	: Bentonite
Seal Interval	: 23 - 25 ft. bgs.
Filter Pack	: 20/40 Silica Sand
Filter Pack Interval	: 25 - 43 ft. bgs.
Total Well Depth	: 42 ft. bgs.
Well Diameter	: 2 in.
Total Boring Depth	: 43 ft. bgs.
Borehole Diam.	: 8 in.

NOTES

Soil samples for PID screening and lithology identification were collected from the auger flights at two foot intervals during drilling.

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